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CHEMIA COARTATA; OR, THE KEY TO MODERN CHEMISTRY.

BY
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Entered according to Act of Parliament of Canada, in the year one thousand eight hundred and seventy-five, by
A. H. KOLLMYER, A. M., M. D., in the Office of the Minister of Agriculture, at Ottawa.

PREFACE.

THE present work on Modern Chemistry has been written and published in the hope that it will prove useful to all who, from business occupation or from any other circumstance, may not have sufficient time at their disposal to consult those more voluminous works which have already contributed so much towards the advancement and improvement of this branch of Science. The main object of the author has been to compress into as small a space as possible everything which is actually required to us easily refresh their of style to simplicity of

CORRIGENDA.

Page 6, line 1st, *for non-metallic compounds and their more important compounds, read non-metallic elements, &c.*

Page 16, line 16, NH_3 (Ammonia) ought to have been described at page 10 as one of the compounds of Nitrogen.

Page 52, line 7, *for Didynium, read Didymium.*

Page 70, line 1, *for tallic, read metallic.*

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modern system ;

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And should time and experience prove that it has helped to point out the landmarks which guide the student on his journey through this intricate but interesting study, or that it has served to stimulate him to a more thorough investigation of this noble science, then it will have fully accomplished the desire of

THE AUTHOR.

MONTREAL, November, 1875.

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P R E F A C E .

THE present work on Modern Chemistry has been written and published in the hope that it will prove useful to all who, from business occupation or from any other circumstance, may not have sufficient time at their disposal to consult those more voluminous works which have already contributed so much towards the advancement and improvement of this branch of Science. The main object of the author has been to compress into as small a space as possible everything connected with the study that deserves attention, and to give no more explanatory matter than is actually required to render each subject perfectly intelligible. In order to effect this end, he has sacrificed elegance of style to simplicity of language, and has on some occasions even thrown himself open to the charge of tautology.

The tabular form here adopted is with few exceptions original and affords many advantages, independent of its being more easily remembered and more readily understood.

It will be found to be especially adapted to the wants of

1. Students intending to present themselves for examinations ;
2. Persons who have learned the *old* notation and wish to become acquainted with the *modern system* ;
3. Those who desire to keep themselves posted on this subject, and who can thus easily refresh their memories without doing so at the expense of their other engagements ;

And should time and experience prove that it has helped to point out the landmarks which guide the student on his journey through this intricate but interesting study, or that it has served to stimulate him to a more thorough investigation of this noble science, then it will have fully accomplished the desire of

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CHEMIA COARTATA;

OR,

THE KEY TO MODERN CHEMISTRY.

CHEMISTRY is that branch of the natural sciences which investigates the nature and properties of all bodies entering into the composition of the universe. It investigates the action between the integrant molecules or atoms of bodies, and studies the force or power by virtue of which every combination is effected.

All bodies are divided in Chemistry into *Compound* and *Simple*:—A *Compound body* can be separated into two or more simple ones; a *Simple body* cannot. The simple bodies are called *Elements*, and are 67 in number. Some of these are *Gaseous*, viz. Oxygen, Hydrogen, Nitrogen, Chlorine, and perhaps Fluorine; two only are liquid, viz. Bromine and Mercury; and the remaining 58 are solid; the last (solids) are generally divided into *Non-Metallic* and *Metallic*. All the elements are described under the name of *Inorganic Chemistry*, in contradistinction to a large number of complicated compounds, many of which exist naturally in plants and in animals, called *Organic*.

The elementary bodies are represented in chemical *formulae* and *equations*, by certain characters termed *Symbols*. The symbol not only represents the substance specified, but also a certain amount of that element, that is, its combining quantity or *atomic weight* as it is more properly called; thus, O stands, not only simply for Oxygen, but also denotes that there are 16 parts of it in the compound, or if there be more, the fact is made evident by the addition of a small figure (called the *co-efficient*) placed immediately under the symbol, thus, O_2 , O_3 , meaning twice or thrice 16, that is, 32 and 48 parts, for it is an established law in chemistry that all substances unite in only one proportion, or in multiples of that proportion. Take for instance Oxygen, which unites only in quantities as represented by the figures 16, 32, 48, 64, &c., (multiples of 16) and never in smaller quantities; and Nitrogen, as 14, 28, 42, 56, &c., all multiples of 14, which is its atomic weight.

The following table represents the sixty-four elementary bodies, with their appropriate symbols and atomic weights:—

No.	NAME.	SYMBOL.	ATOMIC WEIGHT.	No.	NAME.	SYMBOL.	ATOMIC WEIGHT.
1	Aluminum.....	Al	27.4	33	Molybdenum.....	Mo	96
2	Antimony (Stibium).....	Sb	122	34	Nickel.....	Ni	58.8
3	Arsenic	As	75	35	Niobium.....	Nb	94
4	Barium.....	Ba	137	36	Nitrogen.....	N	14
5	Beryllium.....	Be	9.4	37	Osmium.....	Os	199.2
6	Bismuth.....	Bi	210	38	Oxygen.....	O	16
7	Boron.....	B	11	39	Palladium.....	Pd	106.6
8	Bromine.....	Br	80	40	Phosphorus.....	P	31
9	Cadmium.....	Cd	112	41	Platinum.....	Pt	197.4
10	Cæsium.....	Cs	133	42	Potassium (Kalium).....	K	39.1
11	Calcium.....	Ca	40	43	Rhodium.....	Rh	104.4
12	Carbon.....	C	12	44	Rubidium.....	Rb	85.4
13	Cerium.....	Ce	92	45	Ruthenium.....	Ru	104.4
14	Chlorine.....	Cl	35.5	46	Selenium.....	Se	79.4
15	Chromium.....	Cr	52.2	47	Silicium.....	Si	28
16	Cobalt.....	Co	58.8	48	Silver (Argentum).....	Ag	108
17	Copper (Cuprum).....	Cu	63.4	49	Sodium (Natrium).....	Na	23
18	Didymium.....	D	95	50	Strontium.....	Sr	8.76
19	Erbium.....	E	112.6	51	Sulphur.....	S	32
20	Fluorine.....	F	19	52	Tantalum.....	Ta	182
21	Gold (Aurum).....	Au	197	53	Tellurium.....	Te	128
22	Hydrogen.....	H	1	54	Terbium?.....	Tb	—
23	Indium.....	In	74	55	Thallium.....	Tl	204
24	Iodine.....	I	127	56	Thorium.....	Th	15.7
25	Iridium.....	Ir	198	57	Tin (Stannum).....	Sn	118
26	Iron (Ferrum).....	Fe	56	58	Titanium.....	Ti	50
27	Lanthanium.....	La	93.6	59	Tungsten (Wolfram).....	W	184
28	Lead (Plumbum).....	Pb	207	60	Uranium.....	U	120
29	Lithium.....	Li	7	61	Vanadium.....	V	51.2
30	Magnesium.....	Mg	24	62	Yttrium.....	Y	61.7
31	Manganese.....	Mn	35	63	Zinc.....	Zn	65.2
32	Mercury (Hydrargyrum).....	Hg	200	64	Zirconium.....	Zr	89.6

The smallest quantity to which a body can be reduced is called an *atom*; it must therefore be regarded as a definite quantity; moreover, the atoms of all bodies are of the same size, yet they are found to differ greatly in weight; and, if the atom of Hydrogen be taken as the standard of comparison, and is counted to weigh *one*, then the atom of Oxygen will be found to weigh 16, that of Nitrogen 14, and that of Sulphur 32, &c.; hence, these numbers are called the *atomic weights*. An atom is the smallest quantity that can enter into combination with another element.

But an atom cannot exist alone as such, *it must be united with another atom*, and the two (or more as is often the case) then constitute a *molecule*; thus, O, H, & N are atoms, and can combine with other bodies, but, if free, then they combine with one of their own atoms, and really exist, as O₂, H₂ and N₂, that is, as molecules. An atom combining with another, forms a molecule, whether the element be the same or not; thus, H and H form one molecule of Hydrogen; H and Cl form one molecule of Hydrochloric acid; and H, C and N form one molecule of Hydrocyanic acid. In other words, one atom cannot exist alone, it must be combined with something else, and if no other presents itself, for which it has a stronger attraction, it will unite with another atom of itself and form a molecule. A molecule on the other hand, may consist of 2, 3, 4, or more atoms, as seen in a molecule of water H₂O, (here are 3 atoms), of Ammonia NH₃, (4 atoms) &c.

Yet, though atoms combine in certain definite proportions, it has been ascertained that their powers of replacing one another in compound bodies vary greatly; thus, *one* atom of Oxygen will replace *two* atoms of Hydrogen in any compound; while one atom of Nitrogen will take the place of *three* of Hydrogen; and an atom of Carbon displaces *four* of Hydrogen or *two* of Oxygen. This has led to their being arranged into groups that will show their power of replacing each other in chemical compounds;—this is called their *Quantivalence*. Thus, the elementary atoms are divided into *Monivalent* or *Monads*; *Divalent* or *Dyads*; *Trivalent* or *Triads*; *Tetravalent* or *Tetrads*, &c.; and the elements are said to be *Monatomic*, *Diatomic*, *Triatomic*, *Tetrameric*, &c., according to the number of Hydrogen atoms which one atom of each can replace, for the atom H is taken as the standard for comparison and is the typical monad.

The quantivalence of an element is usually expressed by Roman numerals placed after the symbol, thus, H^I (monad), O^{II} (dyad) N^{III} (triad), C^{IV} (tetrad), &c., and it is of the utmost importance that the quantivalence of each atom should be constantly kept in mind, in studying the numerous chemical decompositions as they present themselves, in order that the changes that take place should be thoroughly understood, as the numerals are generally omitted. Roman numerals are used for this purpose, so that they should not be confounded with the ordinary co-efficients which are placed either under or before the atom; thus, O₂, N₃, or 2O and 3N.

The laws regulating chemical combinations are the following:—

- 1st. The law of *Constant proportion*.—The same substance always contains the same elements united in the same proportion.
- 2nd. The law of *Multiple proportion*.—When one body combines with another in several proportions, the higher proportions are always multiples of the first or lowest.
- 3rd. The law of *Reciprocal proportion*.—If two bodies unite with a third, the proportions in which they combine with that third body are measures or multiples of the proportion in which they combine with each other.

The combining quantity of a compound body is the sum of the combining proportions of its constituents; thus, take water (H_2O) we get 2 for Hydrogen and 16 for Oxygen, = (equals) 18, which is the combining quantity of that fluid; and HNO_3 , Nitric Acid would be 1 for the Hydrogen, 14 for Nitrogen, 3 times 16 of Oxygen = (equals) 48, would prove 63 as its combining proportion, which is correct.

Nomenclature.—When one atom of an element unites with the atom of another, in several proportions, distinctive names are given to the compounds so formed; thus, we might have with a metal and oxygen M_2O , MO , M_2O_3 , MO_2 , MO_3 , MO_4 , &c., and these are distinguished as *suboxide*, *monoxide*, *sesquioxide*, *dioxide*, *trioxide* and *tetroxide* respectively; the compound resulting being always called an *ide*. If Chlorine, Iodine, Sulphur, or, in fact, any non-metallic element were substituted for the Oxygen, then Chlorides, Iodides, and Sulphides would be formed, which might be either sub-, mono-, sesqui-, di-, tri-, or tetrasulphides, according to the number of atoms of each united with one of the metal.

If two acids are formed with one element, then the name of the higher terminates in *ic*, and the lower in *ous*; as Sulphuric, Sulphurous, Nitric, Nitrous, &c.

There are two methods of ascertaining the composition of any substance; these are:—

- 1st. *By Synthesis*, or forming the substance by bringing the elements of which it is composed together by appropriate means.
- 2nd. *By Analysis*, or decomposing the body and separating it into its simple elements. The latter may be of two kinds:—
 - (a) *Qualitative Analysis*, which merely finds out the ingredients, and,
 - (b) *Quantitative Analysis*, which ascertains the amount of each ingredient present.

A *Chemical Formula* represents a molecule either of an element or of a compound. It has four functions:—

- 1st. It indicates at a glance the names of the elements in a molecule.

2nd. Its symbol or symbols, together with a small figure attached to the foot of any symbol, show the number of atoms in a molecule.

3rd. It stands for a constant weight of a compound, the molecular weight, that is, the sum of the weights of the atoms in a molecule.

4th. It represents two volumes of the substance in a state of gas or vapor. In the case of bodies that cannot be volatilized, this statement is only probably correct.

A volume means a measure. The combining volumes of all elementary gases are equal, excepting those of Phosphorus and Arsenic which are only half those of the other elements in the gaseous state, and those of Mercury and Cadmium which are double those of the other elements.

A Chemical Equation or a Chemical Diagram is a collection of formulæ and symbols, so placed on paper as to form a picture or illustration of the state of things *before* and *after* that attack of molecules on each other, which results in the formation of new substances.

A Chemical Compound is one in which definite weights of constituents have combined, and during combination have undergone an entire change of properties. A "compound," in pharmacy, is an intimate mixture of substances, but still only a mixture; it is not a chemical compound, the ingredients have not entered into chemical union or combination.

A Solid is a substance, the molecules of which are more or less immobile, though probably not in absolute contact.

A Liquid is a substance whose molecules move so freely about each other that it readily assumes and retains the form of any vessel in which it is placed.

A Gas is a substance, the molecules of which are so far apart that they seem to have lost all attraction for each other, and indeed to have acquired the property of repulsion to such an extent that they are only prevented from receding to a still greater extent by the pressure of surrounding matter.

Gravity means simply weight; but *specific gravity* means *relative weight*, or weight compared to a standard. *Air* is taken as the standard of comparison for gases, and *water* for liquids and solids; but only because they are more convenient and always at hand; anything else would serve the purpose as well, but might not be so easily procured. Lately, Hydrogen, being the lightest of all known substances, has been proposed as the standard, and much can be said in favor of its adoption. *Density* means the comparative mass, and is often used synonymously with *specific gravity*, as they bear such a close relationship, (for weight depends on the amount of the mass) though their meaning is in reality altogether different.

Note.—An acute accent is often used in this work to represent the word acid; thus, Sulphuric', Nitric', Phosphoric', &c.

SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
Oxygen.	Empyrean air. Dephlogisticated air.	Disc. in 1774 by Scheele and Priestley. Forms 1-5th of air, " 8-9ths of water. " 2-3rds of earth.	(1) Mercuric Oxide. (2) Manganese dioxide. (3) Potassium Chlorate.	(1) HgO heated = $\text{Hg} + \text{O}$ (2) 3MnO_2 heated = $\text{Mn}_3\text{O}_4 + \text{O}_2$ (3) KClO_3 heated = $\text{KCl} + \text{O}_2$
	Ozone.	Is allotropic Oxygen. Schonbein 1840.	(1) Phosphorus and Oxygen. (2) Electricity & Oxygen	(1) Let Phosphorus stand in moist Oxygen. (2) Pass Electricity through dry Oxygen.
Hydrogen.	Inflammable air.	Forms 1-9th of water by weight. Disc. by Cavendish 1766.	(1) Zinc and Sulphuric' (2) Zinc and Hydrochloric' (3) Water and Sodium. (4) Steam, and Iron filings heated.	(1) $\text{Zn} + \text{H}_2\text{SO}_4 = \text{ZnSO}_4 + \text{H}_2$ (2) $\text{Zn} + 2\text{HCl} = \text{ZnCl}_2 + \text{H}_2$ (3) $2\text{H}_2\text{O} + \text{Na}_2 = 2\text{NaHO} + \text{H}_2$ (4) $3\text{Fe} + 4\text{H}_2\text{O} = \text{Fe}_3\text{O}_4 + 4\text{H}_2$
	H₂O Water. Hydrogen Monoxide	Exists as vapor, liquid, and solid (Ice). Our Globe is composed of 27 parts of water, to 10 of earthy matter.	Mix 2 volumes of Hydrogen with 1 of Oxygen.	Union can be effected by the aid of an electric spark.

THEIR MORE IMPORTANT COMPOUNDS.

PROPERTIES.		TESTS.
Symbol O. Combining weight 16. Sp. gravity 1.1057. 1 litre weighs 1.43028 grm. 100 c. i. weighs 34 grs.	A gas, without color, odor, or taste, unliquifiable, supports life and combustion, but, if inhaled in excess, will cause death from over-stimulation. It is a Dyad.	1. It will relight a freshly blown-out candle as long as there is a red glow on the wick. 2. It forms red fumes with Nitrogen Dioxide. 3. It turns the <i>white</i> Ferrocyanide of Iron <i>blue</i> . 4. Combustible bodies burn in it with great brilliancy
	It has a strong oppressive odor, oxidizes metals, frees Iodine, Chlorine, &c., corrodes India rubber, bleaches Litmus, heat converts it into ordinary Oxygen. It consists of 3 volumes of Oxygen, condensed into 2 of Ozone, and, when it oxidizes a metal, it does so without any diminution in bulk.	Saturate paper with a Solution of Starch and of Potassium Iodide; on exposure to air, if Ozone be present, it turns <i>blue</i> , from freeing the Iodine and forming the <i>blue Iodide of Amiden</i> . It is supposed to be <i>disinfectant</i> .
Symbol H Comb. weight 1 Sp. gr. 0.0692 1 litre weighs 0.08961 grm. 100 c. i. weigh 2.14 grs.	A gas, without color, odor, or taste, unliquifiable, does not support life or combustion, but is not poisonous; when respired it renders the voice puerile; is the lightest of all gases— $14\frac{1}{2}$ times lighter than air.	1. It is inflammable, burns with a pale blue flame, evolving little light, but great heat. 2. Mixed with half its volume of Oxygen, it will explode, forming vapor of water. 3. It gives no red fumes with Nitrogen Dioxide.
Sp. gravity of vapor 0.6220 of liquid 1.000 of ice 0.940	A bluish liquid, freezes at 0°C . (32°F .), boils at 100°C . (212°F .), it reaches its greatest density at 4°C . (40°F .), is 815 times heavier than air; is the greatest solvent known; hot dissolves more than cold, except of Sodium Chloride, Lime and Magnesia.	1. When pure, no residue is left on evaporation. 2. It should form a clear solution with Lead Acetate. It unites with bodies and forms Hydrates; and it may exist in salts as <i>water of crystallization</i> ; the latter can be expelled by heat.

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SUBSTANCE.	SYNONYMS.	HISTORY.		OBTAINED FROM.	DECOMPOSITIONS.																	
H₂O.	Hydrogen Dioxide.	Thenard,	1818.	Barium Dioxide, Water and Carbon Dioxide.	$\text{BaO}_2 + \text{H}_2\text{O} + \text{CO}_2 = \text{BaCO}_3 + \text{H}_2\text{O}$, called also sometimes Oxygenated water.																	
Nitrogen	Azote.	Rutherford,	1772 Forms 4-5ths of air.	(1) Liquor Ammonia and Chlorine gas. (2) Potassium Nitrite and Ammonium Chloride. (3) Phosphorus and Air.	(1) $\text{NH}_3 + 3\text{Cl} = 3\text{HCl} + \text{N}$ (2) $\text{KNO}_2 + \text{NH}_4\text{Cl} = \text{KCl} + 2\text{H}_2\text{O} + \text{N}_2$ (3) Burn the Phosphorus in a bell jar con- taining air, the Oxygen is burnt off and N is left.																	
	The atmosphere.	Is 45 miles deep, and weighs 15lbs. on every square inch of the earth's surface.	The gases composing it are only in a state of mixture and not of chemical combination.	<table><tr><th colspan="3">COMPOSITION OF AIR.</th><td rowspan="4">It also contains Carbonic Acid Gas, 1-2000th part. Ammonia, 1-1,000,000 part. Vapor of water, a variable amount. Ozone, Nitric H₂S, CH₄, SO, traces.</td></tr><tr><th colspan="2">Volume</th><th>Weight</th></tr><tr><td>O</td><td>20.90</td><td>23.10</td></tr><tr><td>N</td><td>79.10</td><td>76.90</td></tr><tr><td colspan="2"></td><td>100.00</td><td>100.00</td><td></td></tr></table>		COMPOSITION OF AIR.			It also contains Carbonic Acid Gas, 1-2000th part. Ammonia, 1-1,000,000 part. Vapor of water, a variable amount. Ozone, Nitric H ₂ S, CH ₄ , SO, traces.	Volume		Weight	O	20.90	23.10	N	79.10	76.90			100.00	100.00
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Volume		Weight																				
O	20.90	23.10																				
N	79.10	76.90																				
		100.00	100.00																			
N₂O	Nitrogen Monoxide Nitrous Oxide Laughing gas.	Priestley,	1785	Ammonium Nitrate, simply heated.	$\text{NH}_4\text{NO}_3 = 2\text{H}_2\text{O} + \text{N}_2\text{O}$ it must be collected over hot water, as cold absorbs it. It should be passed through a solution of Potash and then through another of Ferrous Sulphate, if intended for In- halation.																	

PROPERTIES.		TESTS.
Sp. gr.	1.45	<p>A colorless, transparent liquid, easily decomposed; bleaches, said to be disinfectant.</p> <p>(1) It decolorizes a solution of Potassium Permanganate.</p> <p>(2) It reduces Silver oxide, depositing metallic silver.</p>
Symb.	N	
Comb. weight	14	<p>1. <i>Substances containing Nitrogen</i> heated with 2 parts of Lime Hydrate, and 1 part of Sodium Hydrate, yield <i>Ammonia</i>. If fused in a tube with Potassium, <i>Cyanogen</i> is obtained, and we must then proceed to test for these two gases.</p>
Sp. gr.	0.972	
1 litre weighs	1.25650 grm.	<p>The <i>Oxygen</i> supports animal life; the <i>Nitrogen</i> dilutes the <i>Oxygen</i>; the <i>Carbon Dioxide</i> and <i>Ammonia</i> nourish plants; the <i>Water</i> favours absorption of these; and <i>Ozone</i> purifies the air.</p>
100 cubic inches	30 grs.	
Sp. gr.	1.000	<p>Without color, odor or taste, unliquifiable, supports life and combustion, conducts sound and radiates solar rays.</p>
1 litre weighs	1.29366 grm.	
100 cubic inches	31 grs.	<p>(1) It gives no red fumes with Nitrogen Dioxide.</p> <p>(2) Substances burn in it almost as brilliantly as in Oxygen gas.</p>
Sp. gr.	1.524	
1 litre weighs	0.97172 grm.	<p>A gas, sweet, narcotic, supports combustion, intoxicating, anæsthetic, liquifies by a pressure of 50 atmospheres, solidifies at -48°C (-120°F). Its anæsthetic action is very transient.</p>
100 cubic inches	47 grs.	

SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
N₂O.	Nitrogen Dioxide. Nitric Oxide.	Dr. Hales.	Copper and Nitric'.	$3\text{Cu} + 8\text{HNO}_3 = 3\text{Cu}(\text{NO}_3)_2 + 4\text{H}_2\text{O} + \text{N}_2\text{O}$, Sometimes represented as $(\text{NO})_2$.
N₂O.	Nitrogen Trioxide. Nitrous Anhydride.		(1) 4 volumes of Nitrogen Dioxide & 1 of Oxygen. (2) Arsenic Trioxide, Nitric' and Water.	(1) Expose the mixed gases to a temperature of -18°C . (2) $\text{As}_2\text{O}_3 + 2\text{HNO}_3 + 2\text{H}_2\text{O} = 2\text{H}_3\text{AsO}_4 +$ N_2O_5
H₂N₂O.	Hydrogen Nitrite. Nitrous Acid.		Nitrogen Trioxide and Water.	$\text{N}_2\text{O}_5 + \text{H}_2\text{O} = \text{H}_2\text{N}_2\text{O}_4$ but more frequently written (though less correctly) $(\text{HNO}_2)_2$
N₂O.	Nitrogen Tetroxide. Nitric Peroxide.		Plumbic Nitrate dried and heated.	$2\text{Pb}(\text{NO}_3)_2 = \text{O}_2 + 2\text{PbO} + 2\text{N}_2\text{O}_4$ or $(\text{NO}_2)_4$
N₂O.	Nitrogen Pentoxide. Nitric Anhydride.	Dewille. 1849	Argentie Nitrate and dry Chlorine gas.	$(\text{AgNO}_3)_2 + \text{Cl}_2 = 2\text{AgCl} + \text{O} + \text{N}_2\text{O}_5$
H₂N₂O. OR (HNO₃)₂	Hydrogen Nitrate. Nitric Acid. Aqua Fortis.	Exists naturally as Nitrate of Potash and Soda in certain soils.	Sodium or Potassium Nitrate & Sulphuric'	$\text{K}_2\text{N}_2\text{O}_5 + (\text{H}_2\text{SO}_4)_2 = 2\text{KHSO}_4 + \text{H}_2\text{N}_2\text{O}_4$ or $(\text{HNO}_3)_2$
Carbon.		Found as the Diamond, Plumbago and Coal.		The Diamond is the purest Carbon

PROPERTIES.			TESTS.
$\text{H}_2\text{O} + \text{N}_2\text{O}_5$ $\text{H}_2\text{AsO}_4 +$ HNO_3 NO_2 $\text{H}_2\text{N}_2\text{O}_5$ or C	Sp. gr. 1.0365 1 litre weighs 1.343 grm. 100 cubic inches 32 grs.	A colorless, invisible gas, incombustible, irrespirable, supports combustion only if the substance burns at a high temperature.	(1) It forms <i>orange</i> fumes of N_2O_5 in the air. (2) Ferrous Sulphate in solution dissolves it, and forms a dark <i>brown</i> solution.
		It is at first an orange gas, but condenses to a thin, mobile, blue liquid, which emits orange red vapors.	(1) It gives off <i>orange</i> fumes in the air. (2) Its solution, if warmed, is decomposed into Nitric' and Nitrogen Dioxide.
	1 litre weighs 2.306 grms.	A blue liquid, very unstable, the salts, however, called Nitrites are very permanent.	Nitrous Acid of commerce is only Nitric' impregnated with Nitrogen Tetroxide (N_2O_4)
		An orange colored gas, condenses at 0°C into a volatile yellow liquid, freezes at -32°C .	Water makes it at first <i>green</i> and then deep <i>blue</i> .
		Colorless, 6 sided prisms, it sometimes explodes spontaneously.	Thrown into water it forms Nitric' and great heat is evolved.
	Sp. gr. 1.52	A colorless liquid, odor acrid, stains skin yellow, it forms Nitrates with metals, and these all crepitate on exposure to heat.	1. It reddens Litmus, Morphia, Narcotine and commercial Strychnine. 2. With Copper it evolves <i>orange red</i> fumes of N_2O_5 . 3. It decolorizes a solution of Sulphate of Indigo. 4. A solution of Ferrous Sulphate and a little Sulphuric Acid makes it <i>brown</i> , becoming <i>yellow</i> on boiling. This is the best test. 5. With Hydrochloric' it forms Aqua Regia, which dissolves Gold and Platinum.
	Symb. C Comb. weight 12 Sp. gr. of diamond 3.5 " " of graphite 2.2	It is a solid, <i>crystalline</i> in the Diamond, and <i>amorphous</i> in Charcoal, Lamp and Ivory-blacks.	Mix any Carbonaceous compound with 4 parts of Cupric Oxide (black oxide); heat them in a bent tube, Carbonic Acid gas is given off, which gives a <i>white</i> precipitate with Lime water.

SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
CO	Carbon Monoxide. Carbonous Oxide.	Priestley. 1787	(1) Carbonic acid gas & Charcoal (heated.) (2) Oxalic & Sulphuric (3) Potassium Ferrocyanide, Sulphuric, and Water.	(1) $2\text{CO}_2 + \text{C} = 4\text{CO}$ (2) $\text{H}_2\text{C}_2\text{O}_4 + \text{H}_2\text{SO}_4 = \text{H}_2\text{O}, \text{H}_2\text{SO}_4 + \text{CO}$, + CO separate the 2 latter gases by passing them through a solution of Potash. (3) $\text{K}_2\text{FeC}_2\text{N}_6 + 6\text{H}_2\text{O} + 6\text{H}_2\text{SO}_4 = 2\text{K}_2\text{SO}_4 + 3(\text{NH}_4)_2\text{SO}_4 + \text{FeSO}_4 + 6\text{CO}$.
CO₂	Carbon Dioxide. Carbonic Oxide. Carbonic acid gas. Choke damp. Fixed air.	Black. 1756 Exists naturally in the air, forming 1-2000th part, also found as Carbonates in chalk, &c.	Chalk and Sulphuric It may be obtained as a <i>gas</i> , a <i>liquid</i> , or a <i>solid</i> .	(Gaseous) $\text{CaCO}_3 + \text{H}_2\text{SO}_4 = \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2$. (Liquid) Expose the gas to a pressure of 28 atmospheres. (Solid) Evaporate the liquid, which it will do spontaneously, and 1-8th will solidify.
C₂H₄	Ethylene. Ethene. Olefiant gas.	Discovered by some Dutch chemists in 1796.	Alcohol and Sulphuric	$\text{C}_2\text{H}_4\text{O} + \text{H}_2\text{SO}_4 = \text{H}_2\text{O}, \text{H}_2\text{SO}_4 + \text{C}_2\text{H}_4$, it is very commonly called <i>Heavy Carburetted Hydrogen</i> .
CH₄	Methane. Marsh gas. Fire damp.	Dumas. Exists in coal mines and in stagnant waters.	Sodium Acetate, Sodium Hydrate & Quicklime.	$\text{NaC}_2\text{H}_3\text{O}_2 + \text{NaHO} = \text{Na}_2\text{CO}_3 + \text{CH}_4$, called also <i>Light Carburetted Hydrogen</i> —the Lime only prevents the Sodium Hydrate from attacking the glass retort.

The four elements which have been thus far described, may be taken as types of those that are to follow, being respectively, Monadic H, Dyadic O, Triadic N, and Tetradic C,—(so named according to their power of replacing or saturating one another in compound bodies:)—these are often described as possessing a certain number of *bonds* which require to be satisfied before each is saturated; thus, $\text{H} \quad \text{O} \quad \text{N} \quad \text{C}$ and each bond is capable of uniting with one atom of a monadic element; 2 bonds with 2 monads, or 1 dyad; 3 bonds with 3 monads, or 1 monad and 1 dyad; 4 bonds with 4 monads, or 2 dyads

PROPERTIES.			TESTS.
$\text{C}_2 + \text{CO}_2$ gases by of Potash. $= 2\text{K}_2\text{SO}_4$ O_2	Sp. gr. 0.967 1 litre weighs 1.251 grm. 100 cubic inches 30 grs.	A gas, no odor, color, taste, unliquifiable, more poisonous than Carbon dioxide, it burns with a blue flame, generating Carbonic acid gas.	(1) If mixed with Oxygen and the electric spark applied it will explode producing CO_2 . (2) It forms with Chlorine gas, a pungent acid compound, called <i>Phosgene gas</i> .
$\text{C}_2 + \text{H}_2\text{O}$ pressure of 28	Sp. gr. 1.524 1 litre weighs 1.966 grm. 100 cubic inches 47 grs.	(<i>Gas.</i>) Colorless, pungent odor and taste, very poisonous, water absorbs its own volume. (<i>Liquid.</i>) Colorless, destitute of all acid properties. (<i>Solid.</i>) White, snow-like flakes.	(1) Extinguishes flame. (2) Lime water throws down a <i>white</i> precipitate of CaCO_3 . (3) The gas is soluble in solution of Potash. (4) With water it forms Carbonic Acid (H_2CO_3). (5) The solid mixed with Ether in vacuo produces a degree of cold equal to -100°C (-148°F .) (6) Solution of Potash dissolves the gas.
C_2H_4 , it is <i>Carburetted</i>	Sp. gr. 0.981 1 litre weighs 1.252 grm. 100 cubic inches 30 grs.	A colorless gas garlic-like odor, does not support life or combustion, burns with a very bright white flame, forming CO_2 and H_2O .	Chlorine forms with it an oily fluid called <i>Dutch Liquid</i> or Ethylenic dichloride; thus: $-\text{C}_2\text{H}_4 + \text{Cl}_2 = \text{C}_2\text{H}_4\text{Cl}_2$.
CH_4 , called <i>Hydrogen</i> —the <i>Hydrate</i> <i>of Carbon</i>	Sp. gr. 0.559 1 litre weighs 1.715 grm. 100 cubic inches 17 grs.	A gas, no color, or odor, unliquifiable, not poisonous, burns with a yellow and less brilliant flame than C_2H_4 .	It forms an explosive compound with air, which is the cause of those terrible accidents so common in coal mines.

or 1 triad and 1 monad; or 2 monads and 1 dyad.

The non-metallic elements may accordingly be arranged into the following groups:

Monads—Hydrogen, Chlorine, Iodine, Bromine, Fluorine.

Triads—Nitrogen, Phosphorus, Boron.

Dyads—Oxygen, Sulphur, Selenium, Tellurium.

Tetrads—Carbon, Silicium.

SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
Chlorine	Oxymuriatic Acid Gas.	Scheele. 1774	(1) Manganese Dioxide, Hydrochloric' and Sulphuric'. (2) Manganese Dioxide and Hydrochloric'.	(1) $2\text{HCl} + \text{MnO}_2 + \text{H}_2\text{SO}_4 = \text{MnSO}_4 + 2\text{H}_2\text{O} + \text{Cl}_2$ (2) $\text{MnO}_2 + 4\text{HCl} = \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$
HCl	Hydrogen Chloride. Hydrochloric Acid. Chlorhydric Acid. Muriatic Acid.	Priestley. 1772 Called commonly Spirits of Salts.	Sodium Chloride and Sulphuric'.	$2\text{NaCl} + \text{H}_2\text{SO}_4 = \text{Na}_2\text{SO}_4 + 2\text{HCl}$. This gas dissolved in water forms the Muriatic' of commerce and contains about 42 per cent. of pure acid.
	Nitrohydrochloric'. Nitryl Chloride.	Aqua Regia.	Hydrochloric' & Nitric'.	$2\text{HNO}_3 + 6\text{HCl} = 2\text{NOCl}_2 + 4\text{H}_2\text{O} + \text{Cl}_2$
Cl₂O	Hypochlorous Anhydride.	Balard. 1834	Mercuric Oxide and Chlorine.	$2\text{HgO} + \text{Cl}_2 = \text{HgCl}_2 + \text{HgO} + \text{Cl}_2\text{O}$
H₂Cl₂O₂	Hypochlorous Acid.		Chalk, Water and Chlorine.	$\text{CaCO}_3 + \text{H}_2\text{O} + \text{Cl}_2 = \text{CO}_2 + \text{CaCl}_2 + \text{H}_2\text{Cl}_2\text{O}_2$, more commonly written $(\text{HClO})_2$
Cl₂O₃	Chlorous Anhydride.	Regnault.	Potassium Chlorate, Arsenious Oxide & Nitric'.	$2\text{KClO}_3 + \text{As}_2\text{O}_3 + 2\text{HNO}_3 + 2\text{H}_2\text{O} = 2\text{H}_3\text{AsO}_4 + 2\text{KNO}_3 + \text{Cl}_2\text{O}_3$

PROPERTIES.		TESTS.
Symbol Cl	A yellowish green gas, odor peculiar, irrespirable when pure, soluble in water; liquifies by 4 atmospheres; unites with water and forms yellow crystals. Hydrogen and some metals take fire in it spontaneously. It is disinfectant.	(1) Its odor; (2) Its color; (3) It bleaches. (4) Silver Nitrate throws down a <i>white</i> precipitate of AgCl. (5) It frees Iodine from Potassium Iodide, and if Starch be present, it furnishes the <i>blue Iodide of Amiden</i> . (6) Paper dipped in Oil of Turpentine takes fire in it.
Sp. gr. 2.453	A colorless gas, poisonous, liquifiable by 40 atmospheres, not inflammable, does not support combustion, water dissolves 480 times its bulk, it fumes on exposure to moist air.	(1) Ammonia gives <i>white</i> fumes (NH ₄ Cl) with the gas and vapor. (2) The liquid evolves Chlorine with Manganese Dioxide. (3) Silver Nitrate gives a <i>white</i> precipitate, AgCl (if the acid be diluted) which blackens on exposure and is soluble in Ammonia.
Comb. weight 35.5		
1 litre weighs 3.173 grms.		
100 cubic inches 74 grs.		
Sp. gr. gas 1.269	A yellow liquid, containing free chlorine.	It dissolves Gold and Platinum, but not Silver.
" " liquid 1.17		
1 litre weighs 1.631 grm.	A pale yellow explosive gas, odor peculiar, condenses to a red liquid at (0° F.)—16° C	It bleaches. Ink, port wine, and fruit juice stains can be removed by a solution of the Hypochlorites and a little vinegar.
100 c. i. 38 grs.		
	A yellow liquid, of a sweetish odor and acid taste, decomposing on an elevation of temperature.	
	A yellow gas, liquifiable by extreme cold.	

O₂+2H₂O+Cl₂This gas
Muriatic
out 42 per+Cl₂+H₂Cl₂O₂
(O)₂O=2H₂As

SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
H,Cl,O.	Chlorous Acid.			Condense Chlorous Anhydride gas in water.
Cl,O.	Chlorine Tetroxide.		Potassium Chlorate and Sulphuric'.	$6KClO_3 + 3H_2SO_4 = 3K_2SO_4 + 2H_2O + 2Cl_2O_4$ (collect by displacement)
Cl,O.	Chloric Anhydride.			Has never been isolated.
H,Cl,O.	Chloric Acid.	Gay Lussac.	Potassium Hydrate, Chlorine gas and Hydrofluosilicic'.	$3K_2O + Cl_2 = 5KCl + KClO_3$, the latter crystallizes out first, and the K is to be removed from it by Hydrofluosilicic'.
Cl,O.	Perchloric Anhydride.			Has not yet been obtained free, but heat, $4KClO_4 = O_2 + 2KCl + K_2Cl_2O_7$, results.
H,Cl,O.	Hydrogen Perchlorate, Perchloric Acid.	Penny.	Potassium Perchlorate and Sulphuric'.	$K_2Cl_2O_7 + 2H_2SO_4 = 2KHSO_4 + H_2Cl_2O_7$ or $(HClO_4)_2$; the acid is collected by distillation.
NCl.	Nitrogen Tetrachloride	Dulong 1812	Salammoniac & Chlorine	$NH_4Cl + 6Cl = 4HCl + NCl_3$
NH.	Ammonia.		Salammoniac and Quicklime.	$CaO + 2NH_4Cl = CaCl_2 + H_2O + 2NH_3$, water at 20°C (68°F) dissolves 681 times its volume.
Iodine		Courtois 1812	From <i>kelp</i> or the half vitrified ashes of the <i>Fucus palmatus</i> & other seaweeds.	Lixivate the ashes with water, evaporate to remove the less soluble salts, then add Manganese dioxide and Sulphuric', and distill. $2KI + MnO_2 + 2H_2SO_4 = K_2SO_4 + MnSO_4 + 2H_2O + I_2$

Sp. gr.

Sp. gr.

Sp. gr.

Symbol
Comb. wei
Sp. gr.
" " vap
1 litre wei



PROPERTIES.		TESTS.
	A greenish-yellow liquid, it bleaches.	It does not decompose Carbonates.
	A deep yellow gas, explosive, condensable, soluble in water. Mercury decomposes it.	The <i>Euchlorine</i> of Davy, prepared from Potassium Chlorate and Hydrochloric' was a mixture of $\text{Cl}_2\text{O}_2 + \text{Cl}$.
	Salts containing it, however, are common.	A Chlorate in solution may be detected by Sulphuric', which turns it yellow and evolves the odor. When heated, Chlorates evolve Oxygen. They give no precipitate with Silver Nitrate. They do not bleach.
	The solution may be evaporated to a syrupy consistency; it must not be filtered as it will set fire to paper.	
	This salt is called Potassium Perchlorate.	
Sp. gr.	1.782	A colorless liquid, fumes, explosive, with water it forms crystals; a powerful oxidizer.
		In contact with Charcoal, Ether, and other organic substances, it explodes violently.
Sp. gr.	1.653	An oily liquid, very volatile, the vapor irritates the eyes; oils cause it to explode.
		The most dangerously explosive substance known.
Sp. gr.	0.59	A colorless gas, odor pungent, water dissolves 1140 times its volume at 0°C . (32°F .)
		It is alkaline and gives white fumes with Chlorine gas and with the vapor of Hydrochloric'.
Symbol	I	(1) Its odour; (2) Its colour when volatilized.
Comb. weight	127	(3) Solution of Starch gives the <i>blue</i> Iodide of Amiden. If the Iodine be in combination as in KI, then Cl or an acid must be added before the Starch test can be applied.
Sp. gr.	4.948	
" vapor	8.716	
1 litre weighs	11.36 grms.	
	A blueish gray solid, volatilizes as a violet vapor, Chloroform dissolves it, and separates it from its watery solutions. Soluble in 7000 parts of water, but more freely in Alcohol and in Alkaline solutions.	

SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
HI	Hydrogen Iodide. Hydriodic Acid.		(1) Phosphorus, Iodine Water. (2) Iodine, Sulphuretted Hydrogen & Water.	(1) $P_2 + I_2 + 6H_2O = 2H_3PO_3 + 6HI$. (2) I_2 suspended in $H_2O + H_2S = S$ deposited and 2HI remains in solution.
NI	Nitrogen Iodide.		Iodine and Liquor Ammonia.	$6I + 4NH_3 = 3NH_4I + NI_3$
Bromine		Balard. 1826 It exists in sea water as Magnesium Bromide.	Sea water, Chlorine, Ether, Solution of Potash, Manganese dioxide, Sulphuric'.	Evaporate sea water and remove the less soluble salts, pass Cl through to free the Br. from the Magnesium; add Ether which brings the Br. to the surface, separate the Ethereal solution by a pipette; add the KHO and evaporate to dryness; then add the MnO_2 and H_2SO_4 (a) $MgBr_2 + Cl_2 = MgCl_2 + Br_2$ (b) $5KHO + 3Br_2 = 3H_2O + KBrO_3 + 5KBr$ (c) $2KBr + MnO_2 + 2H_2SO_4 = K_2SO_4 + MnSO_4 + 2H_2O + Br_2$
Fluorine		Exists as Fluor-spar.		Has never been isolated.
HF	Hydrogen Fluoride. Hydrofluoric Acid.	Scheele.	Fluor Spar and Sulphuric'.	$CaF_2 + H_2SO_4 = CaSO_4 + 2HF$
H₂SiF₆	Hydrofluosillic Acid. Hydrogen Fluosilicate.		Fluor Spar, Sulphuric', Glass, and Water.	(a) $CaF_2 + H_2SO_4 = CaSO_4 + 2HF$ (b) $4HF + SiO_2 = 2H_2O + SiF_4$ (c) $3SiF_4 + 4H_2O = SiH_4O_4 + 2H_2SiF_6$

PROPERTIES.		TESTS.
	An acid gas, fumes, soluble in water. The solution spoils in a very short time, the Iodine being set free.	Two oxides of Iodine exist but are unimportant, they are I_2O_5 and I_2O_4 . Compounds are also formed with Nitrogen and Chlorine.
	A dark powder, explodes, often spontaneously.	The slightest touch will cause it to explode even under water.
Symb. Br. Comb. weight 80 Sp. gr. 2.976 " " vapor 5.41 1 litre weighs 6.99 grms.	A brownish red liquid, suffocating odor, produces symptoms of Influenza or Catarrh for several days after it has been inhaled. It is poisonous, bleaches, is disinfectant, soluble in 33 parts of water, but freely in Alcohol, Ether, and Chloroform; freezes at $-7^{\circ}C$ ($19^{\circ}F$.) boils at $63^{\circ}C$ ($143^{\circ}F$.)	1. Silver Nitrate gives a light <i>yellow</i> precipitate but sparingly soluble in Ammonia. 2. Solution of Starch gives an <i>orange</i> Bromide of Amiden. Hydrobromic' may be prepared like Hydriodic'. Bromic' & Hypobromous' are prepared by the same means adopted for getting the corresponding Chlorine compounds. Ether will separate Bromine from any of its watery solutions and rises to the surface of the liquid with it, acquiring a yellow or red color from it: Chloroform does the same but sinks to the bottom of the fluid.
Symb. F. Weight 19	Supposed to be a gas.	It attacks and destroys all vessels used to obtain it.
Sp. gr. 1.0609	A corrosive fluid, fumes very irritating, used in the arts to etch on glass.	Its etching on glass is a delicate test for its presence. No compound of Fluorine and Oxygen is known.
	The solution is separated by filtration and is kept to precipitate the Salts of Potash.	Any salt of Potash is thrown down by this acid as an insoluble <i>Hydrofluosilicate</i> .

SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITION.
Sulphur		Native in Sicily, California, &c., occurs also as metallic Sulphides and Sulphates.	The native Sulphur.	Distill it in clay vessels into receivers; melt, pour into wooden moulds, when it constitutes <i>Brimstone</i> ; when this is sublimed into large chambers it forms <i>Flowers of Sulphur</i> ; and this again washed well with water is <i>Sulphur Lotum</i> .
SO₂	Sulphur dioxide. Sulphurous oxide. Sulphurous Anhydride.		Copper and Sulphuric'.	$\text{Cu} + 2\text{H}_2\text{SO}_4 = \text{CuSO}_4 + 2\text{H}_2\text{O} + \text{SO}_2$, must be collected over mercury, as water takes up 30 times its own volume of the gas.
H₂SO₃	Sulphurous Acid. Hydrogen Sulphite.	Stoht.	Sulphur dioxide and Water.	$\text{SO}_2 + \text{H}_2\text{O} = \text{H}_2\text{SO}_3$
SO₃	Sulphur Trioxide. Sulphuric Anhydride.	Sulphuric oxide Anhydrous Sulphuric'.	Nordhausen Sulphuric Acid.	Distill the acid and collect in a cooled receiver.
H₂SO₄	Sulphuric Acid. Hydrogen Sulphate.	Valentine, 15th century (a) Commercial. (b) Nordhausen.	{ Nitric Acid vapor Sulphurous Anhydride Steam, and Air. Heating Ferrous Sulphate.	(a) $2\text{HNO}_3 + 3\text{SO}_2 + 2\text{H}_2\text{O} = \text{N}_2\text{O}_5 + 3\text{H}_2\text{SO}_4$, the N_2O_5 absorbs O_2 from the air and becomes N_2O , then $\text{N}_2\text{O} + 2\text{SO}_2 + 2\text{H}_2\text{O} = \text{N}_2\text{O}_3$ again $+ 2\text{H}_2\text{SO}_4$, and this change from N_2O to N_2O_3 continues till all the SO_2 is converted by aid of the steam present into H_2SO_4 . (b) $2\text{FeSO}_4 = \text{Fe}_2\text{O}_3 + \text{SO}_2 + \text{SO}_3$, which unites with the basic water in the salt, thus, $2\text{SO}_3 + \text{H}_2\text{O} = \text{H}_2\text{S}_2\text{O}_7$, it seems to be made up of $\text{H}_2\text{SO}_4 + \text{SO}_3$.

PROPERTIES.			TESTS.
Symb.	S	A yellow solid, crystalline or amorphous, insoluble in Water and Alcohol, but dissolves in Turpentine, Oils and Carbon Disulphide; it melts at 111°C. (232°F.), gets thick at 249°C. (488°F.); at 400°C (792°F.) it gets thin again and boils.	(1) Its color; (2) It burns forming SO ₂ gas; (3) Small quantities may be detected by boiling it with <i>Solution of Potash</i> and <i>Lead Acetate</i> when it becomes <i>brownish black</i> . There are several allotropic (<i>i. e.</i> modified) forms of Sulphur: (a) <i>Prismatic</i> ; (b) <i>Octahedral</i> ; (c) <i>Brimstone</i> ; (d) <i>Plastic</i> ; (e) <i>Black</i> ; (f) <i>Blue</i> .
Comb. weight	32		
Sp. gr.	1.98—2.04		
" " vapor	2.22		
1 litre weighs	2.867 grms.		
Sp. gr.	2.21	A colorless, suffocating poisonous gas, does not support combustion, liquifies at —17°.8C. (0°F.); at —6°C. (17°F.), with water vapor it crystallizes.	(1) It bleaches Litmus &c.; (2) Its odour; (3) It is acid; (4) It frees Iodine and if Starch be present, it produces the <i>blue</i> Iodide of Amiden (or sometimes called Iodide of Starch.)
1 litre weighs	2.8605		
100 cubic inches	68 grs.		
		A colorless liquid, with the characteristic smell of burning sulphur.	1. Apply the same tests as for SO ₂ gas. 2. It reduces Gold Chloride and precipitates metallic Gold.
Sp. gr.	2.77	White silky crystals resembling asbestos.	Deliquescent; hisses like hot iron if put into water.
Sp. gr.	1.842	(a) A heavy oily corrosive liquid, which blackens and chars the skin, wood, &c., it boils at 327°C (620°F) and freezes at —26°C (—15°F.)	1. With metallic <i>copper</i> , sulphurous anhydride is given off; known by its odor, &c. 2. Mixed with an equal quantity of <i>water</i> , heat is evolved. 3. <i>Baryta water</i> gives a white precipitate of Barium Sulphate, insoluble in Alkalies, and in all Acids except boiling Sulphuric.
Sp. gr.	1.900	(b) A heavy dark fuming liquid, used only in the arts, chiefly as a solvent for Indigo.	

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SO₂ must be
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SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
H₂S₂O₃	Hyposulphurous Acid. Thiosulphuric Acid.	Known in 1618.	Digest Sulphur with Potassium Sulphite.	$K_2SO_3 + S = K_2S_2O_3$
H₂S₂O₄	Dithionic Acid. Hyposulphuric Acid.		Manganese dioxide, Water, Sulphurous Anhydride, Barium Hydrate & Sulphuric'.	$MnO_2 + 2H_2O + 2SO_2 = MnS_2O_4 + 2H_2O$, the Barium is then added which forms $Ba S_2O_4$ and is decomposed by $H_2SO_4 = BaS O_4 + H_2S_2O_4$
H₂S₂O₅	Trithionic Acid.		Potassium Hyposulphite, and Sulphurous Anhydride.	$2K_2S_2O_5 + 3SO_2 = 2K_2S_3O_6 + S$ the acid may be freed by Hydrofluosilicic acid.
H₂S₂O₆	Tetrathionic Acid.	Fordos & Gelis.	Iodine and Barium Hyposulphite.	$2BaS_2O_6 + I_2 = BaI_2 + BaS_4O_6$ free it with H_2SO_4 .
H₂S₂O₇	Pentathionic Acid.	Wackenroder.	Hydrogen Sulphide and Sulphurous'.	$5H_2SO_5 + 5H_2S = 5S + 9H_2O + H_2S_2O_4$
H₂S	Hydrogen Sulphide. Sulph-hydric Acid. Hydrosulphuric Acid. Sulphuretted Hydrogen.	Scheele. 1777	(a) Ferrous Sulphide and Sulphuric'. (b) Antimonious Sulphide and Hydrochloric'.	(1) $FeS + H_2SO_4 = FeSO_4 + H_2S$ (2) $Sb_2S_3 + 6HCl = 2SbCl_3 + 3H_2S$
H₂S₂	Hydrogen Disulphide		Sulphur, Slaked Lime, Water & Sulphuric'.	(a) $3CaO + S_2 = 2CaS + CaS_2O_3$, (b) $CaS_2 + H_2SO_4 = CaSO_4 + H_2S$
CS₂	Carbon Disulphide.	Lampadius. 1796	Charcoal and Sulphur.	$2S_2 + C = 2CS_2$

PROPERTIES.		TESTS.
	The acid cannot however be freed from the Potassium.	It dissolves Silver Chloride, and is therefore used in Photography.
Sp. gr. 1.347	Colorless, odorless, sour, liquid.	It reddens vegetable blues. The salts do not deposit Sulphur on the addition of an acid.
	It may be concentrated, but is soon decomposed into $S + H_2SO_3 + H_2SO_4$	It gives no precipitate with Baryta or Lead salts.
	$BaSO_4 + H_2SO_4 = BaSO_4 + H_2S_2O_4$	Nitric acid throws down Sulphur with it.
	Colorless, odorless, but with an acid and bitter taste.	
Sp. gr. 1.175 1 litre weighs 1.52 grm. 100 cubic inches 35 grs.	A colorless, inflammable, foetid gas, liquifies by 17 atmospheres, is a narcotic poison, its solution acts as an acid and reddens Litmus.	Salts of <i>Antimony</i> and <i>Cadmium</i> give yellow precipitates; <i>Mercury</i> , <i>Lead</i> , <i>Bismuth</i> , <i>Mercury</i> , and <i>Silver</i> , brown or black; <i>Tin</i> brown or yellow; <i>Antimony orange</i> ; <i>Gold</i> and <i>Platinum</i> , black precipitates. Its odor is also a good test.
Sp. gr. 1.769	A yellow viscid liquid, with an odor like rotten eggs.	Slowly decomposes into S and H_2S . Metallic oxides decompose it immediately.
Sp. gr. 1.272 " " vapor 2.69	A transparent colorless liquid, of great refractive and dispersive powers, foetid odor, inflammable.	It dissolves Sulphur, Iodine, Bromine, Phosphorus, Camphor, Caoutchouc, Gutta Serena, Bitumen and Oils.

SUBSTANCES.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
Selenium		Berzelius 1817 Found as Lead Selenide	Selenium Dioxide, Water & Sulphurous Anhydride.	$\text{H}_2\text{SeO}_4 + 2\text{SO}_2 + \text{H}_2\text{O} = 2\text{H}_2\text{SO}_4 + \text{Se}$
SeO₂	Selenious Anhydride.			Burn Selenium in air or in pure Oxygen gas.
H₂SeO₃	Selenious Acid.		The foregoing and water.	$\text{SeO}_2 + \text{H}_2\text{O} = \text{H}_2\text{SeO}_3$
SeO₂	Selenic Anhydride.			Not yet obtained.
H₂SeO₄	Selenic Acid. Hydrogen Selenate.		Lead Selenate and Sulphuretted Hydrogen.	$\text{PbSeO}_4 + \text{H}_2\text{S} = \text{PbS} + \text{H}_2\text{SeO}_4$
H₂Se	Hydrogen Selenide.	Selenuretted Hydrogen	Iron Selenide and Sulphuric'.	$\text{FeSe} + \text{H}_2\text{SO}_4 = \text{FeSO}_4 + \text{H}_2\text{Se}$
Tellurium		Found as Gold, Silver, & Bismuth Tellurides.	Bismuth Sulpho- Telluride and Sodium Carbonate.	The process for its preparation is very complicated and unimportant. It forms 2 oxides and acids, and with Hydrogen a compound like H ₂ S

As certain French weights and measures have been mentioned, it will not be out of place to give a slight sketch of the *Metrical System*.

A *metre* is a standard measure kept in Paris, with which all other weights and measures are to be compared, (it is about $39\frac{1}{2}$ inches long and is supposed to represent the 1-10,000,000th part of the distance from the equator to the pole). This metre is graduated in 10ths (or *decimetres*); 100ths (or *centimetres*); and 1000ths (or *millimetres*). By this means length is computed; using, however, *Greek numerals* whenever the quantity is greater than a metre; thus 10 metres is a *Decametre*; 100 a *Hectometre*; and 1000 a *Kilometre*; while *Latin numerals* are exclusively employed to designate quantities less than a metre.

PROPERTIES.			TESTS.
Symb.	Se	A brownish-red semi-transparent solid with a metallic lustre, it melts at 100°C (212°F.), is volatile, tinges flame blue.	If heated, it smells of decaying horse-radish. It burns, but not as steadily as Sulphur.
Comb. weight	79.5		
Sp. gr.	4.3		
		A crystalline solid.	{ It decomposes Carbonates, Nitrates and Chlorides. It precipitates Lead and Silver salts. It is decomposed by Hydrogen Sulphide.
		A powerful acid, resembling Sulphuric.	
Sp. gr.	2.524	Resembles Sulphuric, decomposes by heat into Selenious and Oxygen.	It dissolves Gold but not Platinum.
Sp. gr.	2.795	A colorless gas, soluble in water, inflammable.	It excites catarrh and destroys the sense of smell.
Symb.	Te	A silvery brittle substance, metallic in appearance, a bad conductor of heat and electricity.	It burns. The compounds are not important, but resemble those of Sulphur and Selenium.
Comb. weight	129		
Sp. gr.	6.26		

For measuring Liquids.—A cubic decimetre is employed and is called a *Litre* ; it is about $1\frac{3}{4}$ pints Imperial measure, (i. e. 20 oz. to the pint). It is also divided into 10ths, 100ths, and 1000ths parts, named also *Deci*-, *Centi*-, and *Millilitres* : 10 litres constitute a *Decalitre* ; 100 a *Hectolitre* ; and 1000 a *Kilolitre*.

For weighing Solids.—A cubic centimetre of water represents a *gramme* and is equal to about $15\frac{1}{2}$ grains. The *gramme* is also subdivided into 10ths, 100ths, and 1000ths or *Deci*-, *Centi*-, and *Milligrammes* ; while 10 *grammes* make a *Decagramme* ; 100 a *Hectogramme* ; and 1000 a *Kilogramme*.

SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
Phosphorus		Brandt 1669 Exists in bone, urine, and albumen. Plants absorb it from the soil, these are eaten by animals and converted into Phosphates.	Bone ashes, Charcoal, Water, Sulphuric'.	(a) $\text{Ca}_3(\text{PO}_4)_2 + 2\text{H}_2\text{SO}_4 = 2\text{CaSO}_4 + \text{CaH}_2(\text{PO}_4)_2$ (b) $\text{CaH}_2(\text{PO}_4)_2 = 2\text{H}_2\text{O} + \text{Ca}(\text{PO}_3)_2$ (c) $3\text{Ca}(\text{PO}_3)_2 + 5\text{C}_2 = \text{Ca}_3(\text{PO}_3)_2 + 10\text{CO} + \text{P}_4$
	Amorphous Phosphorus.	Schrötter.		Heat Phosphorus in Nitrogen, for several days, at a temperature of 240°C (464°F)
PH.	Phosphoretted Hydrogen,	A gas.	Caustic Potash, Phosphorus, Slaked Lime, and Water.	$\text{P}_4 + 3\text{CaH}_2\text{O}_2 + 6\text{H}_2\text{O} = 3\text{CaH}_2\text{P}_2\text{O}_4 + 2\text{PH}_3$
PH.		A liquid.	Calcium Phosphite and Water.	Convey the gas through a tube cooled by a freezing mixture.
P.H		A solid.		Light decomposes PH_3 into ordinary PH_4 and solid P_4H which is often seen on the inside of jars when by exposure to light PH_3 has lost the power of spontaneous inflammability.
H.PO.	Hydrogen Hypophosphite. Hypophosphorous'.		Barium Hypophosphite and Sulphuric'.	$\text{Ba}(\text{H}_2\text{PO}_3)_2 + \text{H}_2\text{SO}_4 = \text{BaSO}_4 + 2\text{H}_3\text{H}_2\text{PO}_3$

ELEMENTS; (TYPE N^{III})

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PROPERTIES.		TESTS.
Symbol	P	To detect Phosphorus, dry the substance, and heat a thin layer on a metal plate in the dark, when it becomes luminous:—or after drying, digest it with Carbon Disulphide, filter, put in a watch glass, floating on hot water, when it should become phosphorescent.
Comb. weight	31	
Sp. gr.	1.77	
" " vapor	4.32	
1 litre weighs	5.542 grms.	At 260°C (500°F) becomes common phosphorus, used for lucifer matches.
Sp. gr.	1.24	If pure is not spontaneously combustible, but usually is so from containing the next substance PH ₃ .
		Spontaneously inflammable; renders the former gas the same when its vapor is present even in the smallest proportion.
		Phosphoretted Hydrogen does not affect the salts of Lead, but those of Silver and Gold deposit their metals by its action.
		It precipitates Gold and Silver from their solutions.

SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
P.O.	Phosphorous Anhydride.			Burn Phosphorus in a little air.
H.P.O.	Hydrogen Phosphite. Phosphorous Acid.		(a) The preceding and Water. (b) Phosphorus Trichloride and Water.	(a) $P_2O_3 + 3H_2O = 2H_3PO_3$ (b) $PCl_3 + 3H_2O = 3HCl + H_3PO_3$
P.O.	Phosphoric Anhydride.			Burn Phosphorus in Oxygen gas.
	Phosphoric Acid.	Hydrogen Metaphosphate $P_2O_5 + H_2O = 2HPO_3$	Silver Metaphosphate and Sulphuretted Hydrogen.	$2AgPO_3 + H_2S = Ag_2S + 2HPO_3$
		Hydrogen Pyrophosphate $P_2O_5 + 2H_2O = H_4P_2O_7$	Silver Pyrophosphate and Sulphuretted Hydrogen.	$Ag_2P_2O_7 + 2H_2S = 2Ag_2S + H_4P_2O_7$
		Hydrogen Orthophosphate $P_2O_5 + 3H_2O = 2H_3PO_4$	Silver Orthophosphate and Sulphuretted Hydrogen.	$2Ag_3PO_4 + 3H_2S = 3Ag_2S + 2H_3PO_4$
Boron		Davy.	Boric Oxide and Sodium	$B_2O_3 + 6Na = 3Na_2O + B_2$
B.O.	Boric Anhydride.	Or Boric Oxide.	Heat Boracic Acid.	$2H_3BO_3 = 3H_2O + B_2O_3$
H.BO.	Hydrogen Borate. Boric Acid. Boracic Acid.	Exists naturally in Tuscany, and as Sodium Borate in Thibet and California.	Borax and Sulphuric'.	$2NaHB_2O_4 + 2H_2SO_4 + 4H_2O = 2NaHSO_4 + 4H_3BO_3$

SUBSTANCE.	SYNONYMS.	HISTORY.	OBTAINED FROM.	DECOMPOSITIONS.
Silicon		Berzelius 1824 Exists in Sand & Quartz	Potassium Silico-Fluoride and Potassium.	$K_2SiF_6 + K_4 = 6KF + Si.$
SiO₂	Silicic Anhydride.	Quartz, Sand, Flint and Agate.	Heat Silicic'	$H_2SiO_3 = H_2O + SiO_2$
H₂SiO₃	Hydrogen Silicate. Silicic Acid.		Potassium Silicate and Hydrochloric'.	$K_2SiO_3 + 2HCl = 2KCl + H_2SiO_3$ must be prepared by Dialysis.*

In the foregoing decompositions it will be observed that a certain element and often a whole group of elements will leave one compound, and attach itself to another, forming a new substance whose characters and properties are perhaps altogether different from those from which it was produced. How do we account for this preference that one chemical body appears to show towards another? The only answer that can be given to this question is that it is due to a *peculiar force* called *Chemical Affinity* or *Chemical Attraction*. To this power we are indebted for the value of our tests; for Barium in solutions will always attach itself to Sulphuric Acid if it be present, Calcium to Oxalic', a Silver Salt to Chlorine, &c.:—for every element appears to possess likes, dislikes or an indifference towards its fellow elements, even in a more marked degree than these propensities exist between human beings.

* This is a process employed in chemical manipulations for separating bodies; it depends upon the fact that all crystallizable substances (called *crystalloids*) can pass in solution through a parchment paper; whilst all gum-like amorphous substances (*colloids*) such as Gelatinous Silicic', &c., cannot pass. The *Dialyzer* used for this purpose is a flat drum or sieve made out of parchment paper into which the substances are thrown, and the drum is then floated on a large surface of water.

PROPERTIES.		TESTS.
Symb. Si	22	The crystalline will cut glass like a diamond. It burns on heating, forming Silicic'.
Density	2.49	
Density.	2.64	Potassium Hydrate (boiling) dissolves it, forming Potassium Silicate.
		It is the chief agent of petrification, a clear limpid fluid, but apt to become jelly-like.

Frequent mention has been made of temperature, and it becomes necessary to understand the differences between the two thermometers most commonly used, Centegrade and Fahrenheits, and the conversion of the degrees of the one into those of the other.

To convert + degrees (i. e. above zero) of F. into C.—Subtract 32, multiply by 5, and divide by 9; thus :—
 $212^{\circ}\text{F}-32=180 \times 5=900 \div 9=100^{\circ}\text{C}.$

• To convert + degrees (i. e. above zero) of C. into F.—Multiply by 9, divide by 5, and add 32; thus :—
 $100^{\circ}\text{C} \times 9=900 \div 5=180+32=212^{\circ}\text{F}.$

To convert — degrees (i. e. below zero) of F. into C.—Add 32, multiply by 5, and divide by 9; thus :—
 $-40^{\circ}\text{F}+32=72 \times 5=360 \div 9=-40^{\circ}\text{C}.$

To convert — degrees (i. e. below zero) of C. into F.—Multiply by 9, divide by 5, and subtract 32; thus :—
 $-40^{\circ}\text{C} \times 9=360 \div 5=72-32=-40^{\circ}\text{F}.$

CHEMISTRY OF THE METALS.

Forty-nine metals are known—these are characterized by being good conductors of heat and electricity, they are susceptible of being polished and of reflecting light; they are usually dense and heavy; malleable, ductile, and tenacious. If a solution of a metallic salt be subjected to electrolytic decomposition, the metal will always be found at the negative pole, showing metals to be electro-positive.

These metals unite with the non-metallic elements and form *salts*. A *salt* may be defined to be the union of an electro-positive with an electro-negative. Salts may be *Deliquescent*; these absorb moisture from the atmosphere and liquify: *Efflorescent* which part with their water of crystallization and fall to powder: and *Permanent* when they suffer no change on exposure.

The same nomenclature is adopted for salts as has already been mentioned with regard to Oxides and Sulphides at page 4, with this distinction, however, that if the name of the acid terminates in *ous*, as Nitrous' and Sulphurous', the resulting salt is called an *ite*; whilst if the acid terminates in *ic*, as Nitric' and Sulphuric', then the salt is styled an *ate*, either of which may be *sub-*, *mono-*, *sesqui-*, *di-*, *tri-*, or *tetrasulphites*, or—*sulphates* as the case may be.

There is a certain class of these bodies known as *Haloid salts*, these contain either Iodine, Chlorine, Bromine, or Fluorine, which elements have been called *Halogens* or salt formers, because they unite so readily with bases and form salts; they are all called *ides*, as Chlorides, Iodides, Bromides and Fluorides.

Monivalent radicals such as Chlorine, Iodine, and Bromine form with one atom of Hydrogen a *normal acid*, such as HCl, HI, &c.; and with an atom of any other basylous radical, ordinary *normal salts*, as NaCl, KCl, KI, &c. But divalent radicals such as Sulphur, Selenium, &c., from the fact that they form with two atoms of Hydrogen, *normal acids*, such as HHSO₄ (or H₂SO₄), and with two atoms of univalent or monad metals *normal salts* as Na₂SO₄, may obviously furnish intermediate bodies containing one atom of Hydrogen, and one atom of metal as KHCO₃, NaHSO₄, &c., these are appropriately termed *acid salts*, because they are neither normal acids nor normal salts: they do not, however, always redden Litmus; in some few cases they are even alkaline in reaction.

An *acid* is a compound body, which has usually a sharp sour taste, and its solutions redden Litmus. It always contains Hydrogen, which element can be replaced by a *basylous radical* or metal and a salt results.

The atomicity of a metal is ascertained by its combination with the monad Chlorine. Frequently we find more than one compound is formed, as with Tin, when we have Stannous Chloride SnCl_2 , and Stannic Chloride SnCl_4 . Is this metal then a dyad or a tetrad? We have no means of ascertaining which it is, with certainty, but we consider the one containing the most Chlorine as indicating the atomicity: and we distinguish such as *ic* salts and those containing the lesser quantity as *ous* salts; examples, Stannous and Stannic Chlorides, Ferrous and Ferric Sulphates.

MONADS	Potassium; Sodium; Ammonium; Caesium; Rubidium; Lithium; Argentum.
DYADS	{ Barium; Strontium; Calcium; Magnesium; Zinc; Cadmium; Copper; Mercury; Lead; Beryllium; Thorium; Yttrium; Erbium; Lanthanum; Didymium.
TRIADS	Aluminum; Cerium; Thallium; Aurum.
TETRADES	{ Platinum; Palladium; Rhodium; Iridium; Ruthenium; Osmium; Stannum; Titanium; Nickel; Cobalt; Iron; Manganese; Uranium; Indium.
PENTADS	Antimony; Arsenic; Bismuth; Vanadium; Tantalum; Niobium.
HEXADS	Chromium; Wolfram or Tungsten; Molybdenum.



NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Potassium	K. Weight 39 Sp. gr. 0.865	Kalium. Davy. 1807	Potassium Carbonate and Charcoal.	$K_2CO_3 + 2C = 3CO + K_2$ distill and collect under Naphtha.
	KCl	Chloride.	Left after heating the Chlorate.	$KClO_3 = 3O + KCl$
	KI	Iodide.	Iron Iodide and Potash Carbonate.	$FeI_2 + K_2CO_3 = Fe^{II}CO_3 + 2KI$
	KBr	Bromide.	Like the Iodide using Bromine.	$FeBr_2 + K_2CO_3 = FeCO_3 + 2KBr$
	K ₂ O	Monoxide.	Potassium Hydroxide and Potassium.	$2KHO + K_2 = H_2 + 2K_2O$
	K ₂ O ₂	Dioxide.	Produced when K ₂ O ₄ is made.	Has never been obtained pure.
	K ₂ O ₄	Tetroxide.	Burn Potassium in dry Oxygen.	$K_2 + O_4 = K_2O_4$
	KHO	Hydroxide.	Potassium Carbonate and Lime Hydrate.	$K_2CO_3 + CaH_2O_3 = CaCO_3 + 2KHO$
	KClO ₃	Chlorate.	Solution of Potash and Chlorine gas.	$3K_2O + Cl_2 = 5KCl + KClO_3$
	K ₂ CO ₃	Carbonate	Wood ashes and Water.	Lixivate, filter, decolorize and evaporate.
	KH ₂ CO ₃	Ricarbonate.	Pass Carbon Dioxide through K ₂ CO ₃ & Water.	$K_2CO_3 + H_2O + CO_2 = 2KHCO_3$

PROPERTIES.	TESTS.
A blue, white, soft, lustrous metal, oxydizes in air, thrown on water it unites with the Oxygen and ignites the Hydrogen.	
In salt bitterish cubes like common salt.	1. Tartaric' gives a white precipitate of Cream of Tartar.
In milk-white, opaque, cubes, anhydrous, fusible.	2. Perchloric' also gives a white precipitate.
Somewhat similar to the Iodide.	3. Hydrofluosilicic' gives a white precipitate.
White, deliquescent, caustic, melts, and volatilizes.	4. Platinic Chloride with a little Hydrochloric acid and a little Alcohol gives a yellow precipitate of the double Chloride ($KPtCl_6$)
Chrome yellow, cakes at 280° .	5. Potash salts tinge the flame of a blow-pipe <i>violet</i> .
White, deliquescent, soluble, alkaline, rods or masses.	6. On spectrum analysis a bright line is seen at the red and another at the limit of the violet band.
Flat, tabular, anhydrous crystals, taste of Nitre.	7. The salts are Alkaline: <i>i. e.</i> they restore the color to Litmus that has been reddened with an acid.
In white crystals, soluble in water, deliquescent.	
In large rhombic prisms, anhydrous, soluble in 4 of water.	

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
	K_2SO_4	Sulphate.	From residue left after making HNO_3 .	Add Potassium Carbonate till effervescence ceases.
	$KHSO_4$	Bisulphate.	K_2SO_4 with more Sulphuric'.	Evaporate, dry, redissolve and recrystallize.
	$K_2SO_4 \cdot SO_3$	Anhydrosulphate.	Sulphate, Sulphuric' and Water.	
	KNO_3	Nitrate.	Occurs <i>native</i> in East Indies.	But may be made <i>artificially</i> .
	K_2S	Monosulphide.	{ Solution of Potash and Sulphuretted Hydrogen, then add as much more Solution of Potash.	$KHS + KHO = H_2O + K_2S$
	K_2S_2	Disulphide.	Expose a Solution of KHS till turbid, then evaporate in vacuo.	$2KHS + O = H_2O + K_2S_2$
	K_2S_3	Trisulphide.	{ Pass vapor of Carbon Disulphide over ignited Potassium Carbonate.	$2K_2CO_3 + 3CS_2 = CO_2 + 4CO + 2K_2S_4$
	K_2S_4	Tetrasulphide.	Reduce K_2SO_4 with CS_2 .	$K_2SO_4 + 2CS_2 = 2CO + SO_2 + K_2S_4$
	K_2S_5	Pentasulphide.	Melt Sulphur with dry Carbonate.	$3K_2CO_3 + S_{12} = 3CO_2 + K_2S_4O_3 + 2K_2S_5$
	KHS	Hydrosulphate.	Pass H_2S through Cautic Potash in solution.	$2H_2S + 2KHO = 2H_2O + 2KHS$

PROPERTIES.	TESTS.
Bitter, neutral, rhombic prisms, anhydrous, soluble in 20 of water.	
Sour, flattened, rhombic prisms, soluble in water.	
Is in delicate needles, is decomposed by a large quantity of water.	
6 sided rhombic prisms, soluble in 7 of water.	
It is doubtful if it has ever been procured pure.	
Orange colored, easily fusible.	
Forms with the Sulphate, <i>Liver of Sulphur</i> .	
The latter is soluble in alcohol and is so separated.	

Names.	Formule, &c.	History, &c.	Prepared From.	Decompositions.
Sodium	Na. Sp. gr. 0.972	Natrium. Davy, 1808.	Obtained like Potassium.	Na_2O ; Na_2O_2 ; NaHO ; NaHCO_3 ; NaHSO_4 ; Na_2S are all prepared like the Potassium salts.
	NaCl	Chloride. Common salt.	Evaporate water of brine-springs.	
	$\text{Na}_2\text{CO}_3, 10\text{H}_2\text{O}$	Neutral Carbonate.	Sodium Chloride, Sul- phuric', Coal, Chalk.	(a) $2\text{NaCl} + \text{H}_2\text{SO}_4 = \text{NaCl} + \text{NaHSO}_4 + \text{HCl}$ (b) $\text{NaCl} + \text{NaHSO}_4 = \text{Na}_2\text{SO}_4 + \text{HCl}$ (c) $\text{Na}_2\text{SO}_4 + 2\text{C} = \text{Na}_2\text{S} + 4\text{CO}$ (d) $\text{Na}_2\text{S} + \text{CaCO}_3 = \text{CaS} + \text{Na}_2\text{CO}_3$
	$\text{Na}_2\text{SO}_4, 10\text{H}_2\text{O}$	Sulphate.	Sodium Chloride and Sulphuric'	$2\text{NaCl} + \text{H}_2\text{SO}_4 = \text{Na}_2\text{SO}_4 + 2\text{HCl}$
	$\text{Na}_2\text{S}_2\text{O}_3$	Hyposulphite.	Sodium Sulphide & S.	$\text{Na}_2\text{SO}_3 + \text{S} = \text{Na}_2\text{S}_2\text{O}_3$
	NaNO_3	Nitrate.	Occurs native in Peru.	Called also Cubic or Chili Nitre.
	NaBO_2	Metaborate.	Borax and Sodium Carbonate.	
	$2\text{BO}_2\text{NaB}_2\text{O}_3, 10\text{H}_2\text{O}$	Biborate or Borax.	Native 'n Thibet & Persia	
	$\text{Na}_2\text{HPO}_4, 12\text{H}_2\text{O}$	Disodic Orthophosphate.	Acid Calcium Phos- phate, and Sodium Carbonate.	$\text{CaH}_2\text{2PO}_4 + \text{Na}_2\text{CO}_3 = \text{CaHPO}_4 + \text{CO}_2 + \text{H}_2\text{O} + \text{Na}_2\text{HPO}_4$
	$\text{Na}_3\text{PO}_4, 12\text{H}_2\text{O}$	Trisodic Orthophosphate	Disodic Phosphate and Caustic Soda.	$\text{Na}_2\text{HPO}_4 + \text{NaHO} = \text{H}_2\text{O} + \text{Na}_3\text{PO}_4$
	$\text{NaH}_2\text{PO}_4, \text{H}_2\text{O}$	Monosodic Orthophos- phate.	Disodic Phosphate and Phosphoric'.	

PROPERTIES.	TESTS.
They all resemble the corresponding Potassium preparations very closely.	
Not deliquescent, as soluble in cold as in hot water, manufactured in England, Spain and Canada.	
Oblique rhombic prisms, efflorescent; undergoes aqueous and igneous fusion—soluble in 2 of water.	
Oblique rhombic prisms, soluble, look as if wet with water.	1. Soda Salts are alkaline.
Large regular soluble crystals.	2. They give no precipitates with the Potash tests.
Deliquescent rhombohedrons.	3. Neither Quicklime nor Potash will evolve Ammonia with Soda Salts.
In large crystals, containing $3H_2O$.	4. Metantimonate of Potash throws down a white precipitate.
Six sided efflorescent crystals.	5. They tinge the blow-pipe flame yellow.
Efflorescent oblique rhombic prisms.	6. On spectrum analysis a bright line is seen in the yellow band.
Six sided slender prisms.	
Prismatic acid crystals.	

$NaHSO_4$;
ium salts.

$O_2 + HCl$
Cl

$CO_2 + H_2$

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
	$\text{Na}_2\text{NH}_4\text{HPO}_4 \cdot 4\text{H}_2\text{O}$	Microcosmic Salt.	Disodic Phosphate and Salammoniac in solutions, filter & evaporate.	$\text{Na}_2\text{HPO}_4 + \text{NH}_4\text{Cl} = \text{NaCl} + \text{Na}_2\text{NH}_4\text{HPO}_4$
	NaPO_3	Metaphosphate.	Heat Microcosmic salt.	$\text{Na}(\text{NH}_4)\text{H}_2\text{PO}_4 = \text{H}_2\text{O} + \text{NH}_3 + \text{NaPO}_3$
	$\text{Na}_4\text{P}_2\text{O}_7 \cdot 10\text{H}_2\text{O}$	Pyrophosphate.	Heat Disodic Orthophosphate.	$2\text{Na}_2\text{H}_2\text{PO}_4 = \text{H}_2\text{O} + \text{Na}_4\text{P}_2\text{O}_7$
Ammonium	NH_4 18		Salammoniac & Mercury.	Place these between Platinum plates and pass electricity through.
	NH_4Cl	Chloride. Salammoniac.	Liquid of gas works and Hydrochloric'.	$\text{NH}_4\text{HO} + \text{HCl} = \text{H}_2\text{O} + \text{NH}_4\text{Cl}$
	$(\text{NH}_4)_2\text{SO}_4$	Sulphate.	Liquid of gas works and Sulphuric'.	$2\text{NH}_4\text{HO} + \text{H}_2\text{SO}_4 = 2\text{H}_2\text{O} + (\text{NH}_4)_2\text{SO}_4$
	NH_4NO_3	Nitrate.	Carbonate and Nitric'.	$(\text{NH}_4)_2\text{H}_2(\text{CO}_3)_3 + 4\text{HNO}_3 = 3\text{CO}_2 + 3\text{H}_2\text{O} + 4\text{NH}_4\text{NO}_3$
	NH_4HCO_3	Bicarbonate.	Solution of Ammonia and CO_2 gas.	$\text{NH}_4\text{HO} + \text{CO}_2 = \text{NH}_4\text{HCO}_3$
	$(\text{NH}_4)_2\text{H}_2(\text{CO}_3)_3$	Sesquicarbonate.	Salammoniac & Chalk.	
	NH_4HS	Sulph-hydrate.	Liquor Ammonia and Sulph-hydric'.	$2\text{NH}_4\text{HO} + 2\text{H}_2\text{S} = 2\text{H}_2\text{O} + 2\text{NH}_4\text{HS}$
	NH_4HO	Hydroxide. Solution of Ammonia.	Salammoniac and Quicklime.	$2\text{NH}_4\text{Cl} + \text{CaO} = \text{CaCl}_2 + \text{H}_2\text{O} + 2\text{NH}_3$ with water, this is supposed to form NH_4HO

PROPERTIES.	TESTS.
White prismatic crystals.	
Transparent, glassy, fusible, deliquescent.	
Brilliant permanent crystals, alkaline, soluble.	
An amalgam is formed, but they cannot be separated.	An <i>amalgam</i> is a solution of a metal in Mercury, which has the power of dissolving many metals, as Gold, Silver, &c.
White tough fibrous masses, difficult to powder.	1. The odor; moreover the salts are all volatilized by heat.
Long flat six sided prisms, soluble in 2 of water.	2. Tartaric' gives a white precipitate.
6 sided prisms, soluble in 2 parts of water.	3. Platinum Chloride gives a yellow precipitate.
In large crystals soluble in 8 parts of water.	4. Silver Nitrate with Ammonia gives a yellow precipitate.
In large crystalline masses.	5. Nessler's test for Ammonia and its salts.—Add a solution of Mercuric Chloride to one of Potassium Iodide and a little caustic Potash, a brown precipitate or coloration is immediately produced, consisting of Dimercur-ammonium Iodide—it is a most delicate test, $2(2\text{KI.HgI}_2) + \text{NH}_3 + 3\text{KHO} = \text{NHg}''\text{I. H}_2\text{O} + 7\text{KI} + 2\text{H}_2\text{O}$.
A foetid solution used for testing.	
A pungent alkaline liquid, sp. gr. 0.891.	

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
	$(\text{NH}_4)_2\text{CO}_3$	Carbamate of Ammonia.	Dry Ammonia and Carbon Dioxide gases mixed and cooled.	Carbamic acid has never been isolated.
	$(\text{NH}_4)_2\text{CO}$	Carbamide.	Dry Ammonia and Phosgene gases.	$2\text{NH}_3 + \text{COCl}_2 = 2\text{HCl} + (\text{NH}_4)_2\text{CO}$
Cæsium	Cs. 12.3	Bunsen. 1860	Waters of Durkheim and Nauheim.	Decompose the Chloride with Mercury and electricity.
Rubidium	Rb. 85	Bunsen. 1860	In Durkheim and Nauheim waters.	Prepared like Cæsium.
Lithium	Li. 7	Arfwedson. 1817	Occurs in minerals.	Prepared like Cæsium. Density, 0.59.
Argentum	Ag. 108	Sp. gr. 10.5	Exists as Sulphides and Argentiferous galena, almost every specimen of native Lead Sulphide contains also Silver Sulphide.	The ore is ground, mixed with common salt, and roasted, which converts the Silver into Chloride, then Iron scraps are added. $6\text{AgCl} + 2\text{Fe} = 2\text{FeCl}_3 + 3\text{Ag}$
	AgCl.	Chloride.	Nitrate and Sodium Chloride.	$\text{AgNO}_3 + \text{NaCl} = \text{NaNO}_3 + \text{AgCl}$
	AgI.	Iodide.	Nitrate and Potassium Iodide.	$\text{AgNO}_3 + \text{KI} = \text{KNO}_3 + \text{AgI}$
	Ag ₂ O	Monoxide.	Nitrate and solution of Potash.	$2\text{AgNO}_3 + \text{KHO} = \text{KNO}_3 + \text{HNO}_3 + \text{Ag}_2\text{O}$
	AgNO ₃	Nitrate.	Silver and Nitric acid.	$\text{Ag} + \text{HNO}_3 = \text{H} + \text{AgNO}_3$

PROPERTIES.	TESTS.
Condenses in white flocks.	
A white crystalline powder, a neutral substance.	
A rare metal, discovered by spectrum analysis.	It gives two blue lines in the spectrum.
Also rare and discovered like the preceding.	It gives two red lines in the spectrum.
Soft, reddish, white; the lightest solid known.	Gives two bright bands in the spectrum. Tinges flame crimson.
This is afterwards separated by Mercury and the latter is removed by distillation and leaves the Silver. White, brilliant, the best conductor of heat and electricity, 1 grm. may be drawn into 2600 metres of wire, and it can be beaten into leaves 1-4000 mm. thick.	<ol style="list-style-type: none"> 1. Chlorides give a white precipitate (AgCl) soluble in Ammonia. 2. Alkalies give a brown precipitate (Ag_2O) 3. Sulphhydric a black precipitate (Ag_2S) 4. Iron a white precipitate (Ag). 5. Charcoal with Sodium Carbonate and blow-pipe give metallic Ag 6. Sodium Orthophosphate gives a yellow precipitate $\text{Ag}_3\text{P}_2\text{O}_7$ 7. Potassium Chromate or Bichromate a brown precipitate Ag_2CrO_4
A white powder, soluble in Ammonia and Potassium Cyanide.	
Pale yellow, insoluble in Ammonia	
A pale brown powder—2 other oxides exist.	
Flat, tabular crystals, stains the skin black.	

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Barium	Ba. 137	Davy. 1808	Native as Carbonate and Sulphate.	Like Lithium. Sp. gr. 1.5. Decomposes water.
	BaCl	Chloride.	Carbonate and Hydrochloric'.	$\text{BaCO}_3 + 2\text{HCl} = \text{CO}_2 + \text{H}_2\text{O} + \text{BaCl}_2$
	BaO	Oxide.	Heat a Nitrate.	$\text{Ba}(\text{NO}_3)_2 = \text{O} + \text{N}_2\text{O}_5 + \text{BaO}$
	BaH_2O_2	Hydroxide.	Chloride and Sodium Hydroxide.	$\text{BaCl}_2 + 2\text{NaHO} = 2\text{NaCl} + \text{BaH}_2\text{O}_2$
	BaO_2	Dioxide.	Heat Baryta in Oxygen.	$\text{BaO} + \text{O} = \text{BaO}_2$
	γ .	Sulphate.	Native as heavy spar.	
Magnesium	24	Davy. 1808	As Dolomite ($\text{CaCO}_3 + \text{MgCO}_3$).	Like Lithium. Density 1.74
	MgCl_2	Chloride.	Carbonate and Hydrochloric'.	$\text{MgCO}_3 + (\text{HCl})_2 = \text{CO}_2 + \text{H}_2\text{O} + \text{MgCl}_2$
	MgO	Oxide.	Heat Magnesia Alba (Commercial Carbonate)	$\text{Mg}_4\text{CO}_3, \text{MgH}_2\text{O}_2 = 4\text{CO}_2 + 3\text{O} + \text{H}_2\text{O} + 2\text{MgO}$
	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	Sulphate.	Dolomite and dilute Sulphuric'	$\text{CaCO}_3, \text{MgCO}_3 + 2\text{H}_2\text{SO}_4 = \text{CaSO}_4 + 2\text{CO}_2 + 2\text{H}_2\text{O} + \text{MgSO}_4$
	MgCO_3	Carbonate (neutral).	Occurs native.	
	$\text{Mg}_4\text{CO}_3, \text{MgH}_2\text{O}_2 + 6\text{H}_2\text{O}$	Magnesia Alba.	Sulphate and Sodium Carbonate.	Mix the solutions and it falls as a white insoluble powder.

METALS.

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PROPERTIES.	TESTS.
A white metal, oxydizes in air.	
Flat 4 sided tables, colorless or transparent.	1. Carbonates give a white precipitate.
A greyish spongy mass.	2. Sulphates give also a white precipitate.
Fusible white crystals.	3. Tinges flame green.
All the salts of Baryta are poisonous.	4. On spectrum analysis gives a series of green bands.
Soluble only in boiling Sulphuric, but separates in cooling.	
White, ductile, malleable, burns with an intense white flame.	
White, crystalline, deliquescent.	1. Alkalies and their Carbonates give a white precipitate insoluble in excess, but soluble in Ammonium Chloride.
A soft, white, insoluble powder, soluble in CO ₂ water.	2. Any Phosphate with a little Ammonia gives a white precipitate of Ammonio-magnesian phosphate.
Right rhombic prisms, cool, saline, bitter taste.	
In rhombohedral crystals.	
If the solutions are weak, the powder is very light.	

Names.	Formulae, &c.	History, &c.	Prepared From.	Decompositions.
Strontium	Sr. 87	Hope. 1792	Native as Carbonate and Sulphate.	Like Lithium. Density 2.5
Calcium	Ca. 40	Davy. 1808	Native as Carbonate and Sulphate.	Like the former.
	CaO	Oxide (Quicklime).	Heat the Carbonate.	$\text{CaCO}_3 = \text{CO}_2 + \text{CaO}$
	CaH_2O_2	Hydroxide.	Quicklime and Water.	$\text{CaO} + \text{H}_2\text{O} = \text{CaH}_2\text{O}_2$ (Slaked lime.)
	$\text{CaCl}_2, \text{CaCl}_2\text{O}_2$	Chlorinated Lime.	Slaked lime & Chlorine gas.	$2\text{CaO} + \text{Cl}_2 = \text{CaCl}_2, \text{CaCl}_2\text{O}_2$
Cadmium	Cd. 112	Stromeyer. 1817	Found associated with Zinc.	Prepared with Zinc, it comes over first by distillation.
Zinc	Zn. 65	Density 6.8	Found as Carbonate (Calamine).	Roast and mix with Charcoal and distill.
	ZnCl_2	Chloride.	Zinc and Hydrochloric'.	$\text{Zn} + 2\text{HCl} = \text{H}_2 + \text{ZnCl}_2$
	ZnO	Oxide.	Heat the Carbonate.	$\text{ZnCO}_3 = \text{CO}_2 + \text{ZnO}$ (Philosophers' wool).
	$\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$	Sulphate.	Zinc and Sulphuric'.	$\text{Zn} + \text{H}_2\text{SO}_4 = \text{H}_2 + \text{ZnSO}_4$ (white vitriol).
	ZnCO_3	Carbonate.	Native or from Sulphate and Sodium Carbonate	$\text{ZnSO}_4 + \text{Na}_2\text{CO}_3 = \text{Na}_2\text{SO}_4 + \text{ZnCO}_3$
Copper	Cu (Cuprum) 63.5	Density 8.6	Found pure and as pyrites.	Prepared by a very complicated process (unimportant.)
	CuO	Cupric Oxide.	Heat Copper in air.	Or heat the Nitrate.

PROPERTIES.	TESTS.
A heavy white metal, oxydizes in air.	Tinges flame carmine-red. Bright bands in the blue and yellow of spectrum.
A light yellow oxydizable metal.	1. Alkalies and Carbonates give a white precipitate.
11 grs. dissolve in 1 pint of water at 15°C; at 100° only 7 grains.	2. Sulphuric' and Oxalic' give white precipitates. (3) Ammonium Oxalate detects 1-50,000 pt. of a grain. (4) Green and orange bands are seen in the spectrum. (5) The Chloride gives an orange tint to flame.
A white powder called Milk of Lime.	
A disinfectant and bleacher.	
Like Tin but harder, it burns, density 8.7	1. Alkalies and Carbonates give white precipitates. (2) Hydro-sulphuric' a yellow precipitate. (3) Sulphide of Ammonium gives a yellow precipitate.
Blue-white and crystalline.	1. Alkalies and Carbonates white precipitates.
White, fusible, deliquescent.	2. Hydrosulphuric' white precipitate in neutral solutions; none if acid.
A white flocculent powder.	3. Potassium Cyanide a white precipitate.
Soluble, right rhombic prisms.	4. Ammonium Sulphide a white precipitate.
Pink when native; white when precipitated.	5. Charcoal, Sodium Carbonate and the blow-pipe give yellow (ZnO) becomes white on cooling.
A red metal.	1. Alkalies give a pale blue precipitate (CuH_2O_2)
Black, dense, soluble in acids.	2. Ammonia intense blue color. (3) Ammonia Carbonate deep blue.

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Hydrargyrum	Cu_2O	Cuprous Oxide.	Black Oxide & Copper filings.	Heat together; or from Sulphate, Glucose, and Potassium Hydroxide.
	$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$	Sulphate.	Copper and Sulphuric'.	$\text{Cu} + 2\text{H}_2\text{SO}_4 = \text{SO}_2 + 2\text{H}_2\text{O} + \text{CuSO}_4$ (blue vitriol)
	Hg. Density 13.59	Mercury. Quicksilver.	Native pure, and as Cinnabar, &c.	Roast the Cinnabar and collect the Mercury as it sublimes.
	$\text{Hg}^{II}\text{Cl}_2$	Mercuric Chloride.	Mercuric Sulphate and Sodium Chloride.	$\text{HgSO}_4 + 2\text{NaCl} = \text{Na}_2\text{SO}_4 + \text{Hg}^{II}\text{Cl}_2$ (Corrosive Sublimate.)
	Hg_2Cl_2	Mercurous Chloride.	Mercuric Sulphate, Mercury, Sodium Chloride.	$\text{HgSO}_4 + \text{Hg} + 2\text{NaCl} = \text{Na}_2\text{SO}_4 + \text{Hg}_2\text{Cl}_2$ (Calomel.)
	Hg^{II}I	Mercuric Iodide.	Mercuric Chloride and Potassium Iodide.	$\text{Hg}^{II}\text{Cl}_2 + 2\text{KI} = 2\text{KCl} + \text{Hg}^{II}\text{I}_2$
	Hg_2I_2	Mercurous Iodide.	Mercury, Iodine, Spirits of Wine.	$2\text{Hg} + \text{I}_2 = \text{Hg}_2\text{I}_2$
	HgO	Mercuric Oxide.	Heat Mercuric Nitrate.	$2\text{Hg} + 4\text{HNO}_3 = 4\text{NO}_2 + 2\text{H}_2\text{O} + 2\text{HgO}$ (red precipitate.)
	Hg_2O	Mercurous Oxide.	Mercurous Nitrate and Solution of Potash.	$2\text{HgNO}_3 + 2\text{KHO} = 2\text{KNO}_3 + \text{H}_2\text{O} + \text{Hg}_2\text{O}$
	$\text{Hg}^{II}(\text{NO}_3)_2$	Mercuric Nitrate.	Mercuric Oxide and Nitric'.	$\text{HgO} + 2\text{HNO}_3 = \text{H}_2\text{O} + \text{Hg}^{II}(\text{NO}_3)_2$
	$\text{Hg}_2(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$	Mercurous Nitrate.	Mercury & cold Nitric'.	$2\text{Hg} + 4\text{HNO}_3 = 2\text{NO}_2 + 2\text{H}_2\text{O} + \text{Hg}_2(\text{NO}_3)_2$

PROPERTIES.	TESTS.
Transparent, ruby-red crystals, makes glass red.	4. Carbonates pale blue. (5) Potassium Ferrocyanide a reddish brown.
Blue soluble crystals.	6. Sulphhydric' and Ammonium Sulphide give black precipitates.
A white, volatile, liquid metal, freezes at -40° and boils at 350°C . (662°F).	1. All the salts sublime and may be decomposed by heat.
Semitransparent masses or prisms, very poisonous.	2. Charcoal and dried Sodium Carbonate yield metallic Mercury, (this is the reduction test.)
A white powder, insoluble, amorphous, density 7.14.	3. Slips of Copper placed in an acidulated solution become covered with Hg.
A beautiful scarlet powder, sometimes in crystals.	4. Stannous Chloride when in excess precipitates the metal.
An olive green powder.	
In red crystals : yellow when finely powdered.	
A dark grey insoluble powder ; seen also in black wash.	
A syrupy liquid but may be crystallized.	
Large colorless soluble crystals.	

	MERCURIOUS.	MERCURIC SALTS.
1. Sulph-hydric acid precipitates....	Black.	Black.
2. Ammonium Sulphide.....	Black.	Black.
3. Alkalies	Black.	Yellow.
4. Ammonia and its Carbonate	Black.	White.
5. Alkaline Carbonates	White then black	Red-brown.
6. Potassium Iodide.....	Olive Green.	Red.
7. Hydrochloric Acid or } soluble Chlorides }	White.	None.

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Plumbum	Hg ¹ SO ₄	Mercuric Sulphate.	Mercury & Sulphuric'.	Hg+2H ₂ SO ₄ =SO ₂ +2H ₂ O+HgSO ₄
	Hg ¹¹ S	Mercuric Sulphide.	Native, and from Mercury and Sulphur.	Prepared by sublimation— <i>Cinnabar</i> or <i>Vermilion</i> .
	Hg ₂ S	Mercurous Sulphide.	Mercurous Nitrate and Sulph-hydric'.	
	Pb	Density 11.45	Native Sulphide or Galena.	Roast Galena, the Sulphur is driven off as SO ₂
	PbI ₂	Iodide.	Acetate and Potassium Iodide.	Pb (C ₂ H ₃ O ₂) ₂ +2KI=2K (C ₂ H ₃ O ₂) +PbI ₂
	PbO	Oxide.	Heat Carbonate to dull redness.	PbCO ₃ =CO ₂ +PbO (<i>Litharge</i> or <i>Massicot</i> .)
	Pb ₃ O ₄	Red Lead.	Heat Oxide for a long time.	3PbO+O=Pb ₃ O ₄ (Diplumatic Tetroxide.)
	PbO ₂	Dioxide.	Digest red lead in Nitric'.	Pb ₃ O ₄ +4HNO ₃ =2H ₂ O+2Pb (NO ₃) ₂ +PbO ₂
	Pb ₂ O	S ¹ oxide.	Heat the Monoxide.	2PbO=O+Pb ₂ O
	PbCO ₃	Carbonate.	Lead Acetate and Carbon Dioxide gas.	
Beryllium	Be	9.4 Occurs as Silicate.	Chloride and Sodium.	Pass the vapor of the Chloride over Sodium.

PROPERTIES.	TESTS.
A white crystalline powder.	
Red, crystalline or amorphous, used as a paint.	
A black precipitate.	
Blue-white, soft, malleable, volatile at a white heat.	
Yellow powder or in yellow iridescent spangles.	<div>1. Alkalies cause a white precip.</div> <div>2. Carbonates a white precipitate.</div>
In straw-colored plates.	<div>3. Ammonia a white precipitate.</div> <div>4. Sulphuric' a white " "</div>
A red, insoluble powder, used as a paint.	<div>5. Sulph-hydric' a black " "</div> <div>6. Ammonium Sulphide a black.</div>
A deep brown powder called <i>puce brown</i> .	<div>7. Potassium Iodide, yellow " "</div> <div>8. Potassium Chromate, yellow.</div>
A grey powder.	<div>9. Sodium Chloride, white " "</div> <div>10. Potassium Ferrocyanide, white.</div>
A white insoluble powder called <i>White Lead</i> .	<div>11. Charcoal, Sodium Carbonate and the blow-pipe give the metal.</div>
A white metal, often called Glucinum, density 2.1.	<div>Its salts are colorless and sweet; gives no blue bend with Cobalt Nitrate and the blow-pipe.</div>

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Thorium	Th 115.75	Found as Silicates.	Chloride and Sodium.	Like Beryllium.
Yttrium	Y 61.7	Found as Silicates	Chloride and Sodium.	Like Beryllium.
Erbium	Eb 112.6	In Ytterbite.		By a very complicated process of no importance.
Lanthanum	La 92.8	Cerite, Allanite.	Chloride and Sodium.	Like Beryllium.
Didymium	Di 96	Cryolite, &c.	Chloride and Sodium.	Like Beryllium.

An *alloy* is a mixture of metals, which may be either *natural* or *artificial*, the latter being produced by simply fusing the metals together. The alloy formed between Pt, Pd, Rh, Ir and Fe is an illustration of the first variety or *native*, and the following will serve as examples of those artificially prepared:—

Gun metal	Cu 90, Sn 10 parts.	Pewter	Zn 12, Sb 1, Cu (a little).
Bronze	Cu 91, Sn 6, Pb 1.	Plumbers' Solder	Pb 2, Sn 1.
Brass	Cu 28, Zn 34.	Fine Solder	Pb 1, Sn 2.
Bell metal	Cu 78, Sn 22.	Type metal	Pb 73, Sb 17, Sn 10.
Speculum metal	Cu 75, Sn 25.	Standard Silver	Ag 222, Cu 18.
German Silver	Cu 100, Zn 60, Ni 40	Standard Gold	Au 22, Cu (or Ag) 2.
Britannia metal	Sn 9, Sb 1, and sometimes also small quantities of Cu, Zn and Bi.		

When Hg is one of the component metals, the alloy is called an *amalgam*; thus, we have the amalgams of Au, Ag, Sn, NH₄, &c.

PROPERTIES.	TESTS.
A grey powder, acquiring a metallic lustre by pressure.	
A blackish grey powder.	Alkalies precipitate white Hydrates.
Never isolated ; the salts are rose-colored.	Erbia is rose-colored. Characteristic bands are seen in the spectrum.
Grey powder, decomposes water, salts colorless.	Alkalies throw down white Hydrates.
Grey powder, decomposes water, salts rose-colored.	Alkalies cause rose-colored precipitates.

Distillation is an operation in which a volatile substance is converted by heat into a vapor, which is afterwards condensed in a suitable apparatus where it assumes a liquid form. But when the product condenses as a solid then the process is termed *Sublimation*.

When dry organic matter is distilled until all volatile products are expelled, the operation is called *Dry or Destructive Distillation*.

When several volatile substances, having different boiling points, are in a state of mixture, they may be separated by *Fractional Distillation* ; i. e. by collecting the products as they are driven off at different degrees of heat, and condensing them separately.

Precipitation is produced when a body passes to the solid state so rapidly as to prevent the particles from arranging themselves into any regular form, and therefore the substance falls as a more or less fine powder.

Crystallization.—When bodies in passing from the liquid or gaseous states assume regular geometrical forms, the process is termed crystallization, and the solid bodies *crystals*.

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Aluminum	Al 27.4	Density 2.6	Chloride and Sodium.	Like Beryllium.
	Al ₂ Cl ₆	Chloride.	Alumina, Oil, Lamp-black and Chlorine.	Al ₂ O ₃ + C + Cl ₂ = 3CO + Al ₂ Cl ₆ got by distillation.
	Al ₂ O ₃	Oxide (Alumina).	Solution of Alum and Ammonia.	Al ₂ H ₂ O ₆ falls down; this must be ignited Al ₂ O ₃ remains.
	Al ₂ ^{III} (SO ₄) ₃	Sulphate.	Aluminum Hydrate and Sulphuric'.	This Sulphate combines with other Sulphates as Silver, Rubidium and Ammonium forming Alums.
	Al ^{III} NH ₄ (SO ₄) ₃ + 12 H ₂ O	Common Alum.	Is made from Aluminous Clay.	It is roasted, exposed to air, lixiviated with water. Saccharine is added to remove Iron, this is crystallized.
Cerium	Ce 92	Klaproth. 1803	From the Chloride and Sodium.	Like Beryllium.
Thallium	Tl 204	Crookes. 1861	Found in Iron and Copper pyrites.	Subject a solution of the Sulphates to electrolysis.
Aurum (Gold)	Au 196.7	Density 19.5	Found pure, or in alloys: got by dissolving it in Nitromuriatic' and precipitating with Ferrous Sulphate.	2AuCl ₃ + 6FeSO ₄ = 2Fe ₂ ^{III} (SO ₄) ₃ + 2Fe ^{III} Cl ₃ + Au ₂
	AuCl	Aurous Chloride.	Heat Auric Chloride.	AuCl ₃ = Cl ₂ + AuCl
	AuCl ₃	Auric Chloride.	Gold & Nitromuriatic'.	

METALS.

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$\text{Fe}^{III}\text{Cl}_3$

PROPERTIES.	TESTS.																																												
Silver-like, unaffected by air, Sulphuretted Hydrogen, &c.																																													
A transparent, waxy, colorless substance, with a crystalline structure.	1. Alkalies give white precipitates, soluble in excess.																																												
A white, tasteless, coherent mass.	2. Ammonia gives a white precipitate insoluble in excess.																																												
Thin pearly plates, sweet astringent taste and acid reaction.	3. Carbonates give white precipitates insoluble in excess.																																												
Many so called Alums contain no alum, it is replaced by Iron, Manganese, &c. Common Ammonia Alum is in large crystals.	4. Ammonium Sulphide gives a white precipitate of Hydrate.																																												
	5. Any salt of Aluminum with Cobalt Nitrate, gives a very characteristic blue bead with the blow-pipe.																																												
A grey powder, decomposes water, the salts are colorless.	Solid Potassium Sulphate gives a white precipitate with a Cerous salt.																																												
A soft lead-like metal, streaks paper like Plumbago.	1. Gives an intense green line in the spectrum. 2. Communicates a green color to flame. 3. Charcoal, Sodium Carbonate and the blow-pipe reduce it.																																												
A soft yellow metal, soluble in Selenic Acid and in Nitromuriatic, is the most malleable of metals, it may be beaten into leaves 1 200,000 of an inch thick.	<table><tr><th></th><th>THALLOUS.</th><th>THALLIC.</th><th>TESTS FOR GOLD.</th></tr><tr><td>4. Alkalies, Ammonia and Carbonates give</td><td>Nothing.</td><td>Brown precip.</td><td>1. Ferrous Sulphate gives a brown precipitate.</td></tr><tr><td>5. Chlorides and Bromides</td><td>White.</td><td>None.</td><td>2. The blow pipe gives a metallic bead.</td></tr><tr><td>6. Oxalic Acid</td><td>None.</td><td>White precip.</td><td>3. Stannous Chloride gives the Purple of Cassius.</td></tr><tr><td>7. Phosphoric Acid</td><td>White.</td><td>White.</td><td>4. Oxalic Acid slowly reduces Gold.</td></tr><tr><td>8. Arsenic</td><td>Yellow.</td><td>Yellow.</td><td>5. Sulph-hydric gives a black precipitate soluble in Ammonia</td></tr><tr><td>9. Potassium Ferrocyanide</td><td>Yellow.</td><td>Yellow.</td><td></td></tr><tr><td>10. Potassium Ferrocyanide</td><td>Yellow.</td><td>Yellow.</td><td></td></tr><tr><td>11. Potassium Chromate</td><td>Yellow.</td><td>Yellow.</td><td></td></tr><tr><td>12. Platinic Chlorides</td><td>Pale yellow.</td><td>Yellow.</td><td></td></tr><tr><td>13. Iodides</td><td>Yellow.</td><td>Yellow.</td><td></td></tr></table>		THALLOUS.	THALLIC.	TESTS FOR GOLD.	4. Alkalies, Ammonia and Carbonates give	Nothing.	Brown precip.	1. Ferrous Sulphate gives a brown precipitate.	5. Chlorides and Bromides	White.	None.	2. The blow pipe gives a metallic bead.	6. Oxalic Acid	None.	White precip.	3. Stannous Chloride gives the Purple of Cassius.	7. Phosphoric Acid	White.	White.	4. Oxalic Acid slowly reduces Gold.	8. Arsenic	Yellow.	Yellow.	5. Sulph-hydric gives a black precipitate soluble in Ammonia	9. Potassium Ferrocyanide	Yellow.	Yellow.		10. Potassium Ferrocyanide	Yellow.	Yellow.		11. Potassium Chromate	Yellow.	Yellow.		12. Platinic Chlorides	Pale yellow.	Yellow.		13. Iodides	Yellow.	Yellow.	
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A yellowish white mass.	1. Zinc and Iron throw down crystals of Thallium from all its salts.																																												
A red crystalline mass, very deliquescent.																																													

Names.	Formula, &c.	History, &c.	Prepared From.	Decompositions.
Platinum	Pt 19.74	Density 21.5	Exists usually as an alloy of Silver, &c.	The preparation is very complicated.
	Pt ^{II} Cl ₂	Platinous Chloride.	Prepared like Aurous Chloride.	
	Pt ^{IV} Cl ₄	Platinic Chloride.	Platinum and Nitromuriatic'.	
Palladium	Pd 106.5	Density 11.8	Associated with Platinum.	Unimportant.
Rhodium	Rh 104	Density 10.6	Associated with Platinum also.	Unimportant.
Iridium	Ir 198	Density 21.15	Associated with the former.	
Ruthenium	Ru 104	Density 8.6	Associated with the former.	
Osmium	Os 199	Density 10	Associated with the foregoing.	

METALS.

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PROPERTIES.	TESTS.
Forms 2 sets of salts, one set dyad, the other tetrad.	1. Sulph-hydric' and Ammonium Sulphide give a brown precipitate.
Insoluble greenish-grey powder.	2. The Chloride throws down a yellow precipitate with Potash and with Ammonia, but not with Soda, and is used in analysis to separate K from Na.
A red or brown deliquescent mass.	{ 1. Mercury Cyanide gives a yellow precipitate. 2. Potassium Iodide gives a black precip., will detect 1 in 500,000 parts.
Resembles Platinum and also forms 2 sets of salts.	{ 1. Sulph-hydric' and Ammonium Sulphide give a brown precipitate. 2. Sulphates a yellow (pale). (3) Ammonia and Carbonates a yellow. 4. Alkaline Chlorides and Mercury Cyanide give no precipitates. 5. Zinc precipitates metallic Rhodium.
White, coherent, spongy, brittle; salts are pink.	Ammonium or Potassium Chloride gives a dark brown-red precipitate.
A white, brittle metal; forms Iridious and Iridic Salts.	{ 1. Fused with Potassium Nitrate it forms an orange-red solution. 2. Potassium Sulpho-cyanate gives a red, changing to violet on heating. 3. Lead Acetate gives a purple-red precipitate.
Porous masses; also forms 2 sets of salts.	{ 1. Pungent, disagreeable odor when heated, irritating and poisonous. 2. Sulph-hydric' & Ammonium Sulphide give a yellow-brown precipitate. 3. Silver Nitrate, olive-green. (4) Stannous Chloride a brown. 5. Tannin no precipitate, but a blue color. (6) Potassium solutions a dark brown. 7. Potassium Ferrocyanide green and then blue. (8) Potassium Iodide purple-red. 9. Zinc and Sodium Formate throw down metallic Osmium.
A black metal: it forms Osmious and Osmic Salts.	

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Ferrum (Iron)	Fe 56	Density 7.8	Found pure and as Sulphide.	Proceed as for getting Manganese.
	FeCl ₂	Ferrous Chloride.	Iron and Hydrochloric'.	$\text{Fe} + 2\text{HCl} = \text{H}_2 + \text{FeCl}_2$
	Fe ₂ Cl ₆	Ferrie Chloride.	Ferrous Chloride, Hydrochloric' and Nitric'.	$6\text{FeCl}_2 + 6\text{HCl} + 2\text{HNO}_3 = 2\text{NO} + 4\text{H}_2\text{O} + 3\text{Fe}_2\text{Cl}_6$
	FeO	Ferrous Oxide.	Solution of a Ferrous Salt and Ammonia.	Dry the white precipitate in an atmosphere of Hydrogen.
	Fe ₂ O ₃	Ferrie Oxide	Solution of a Ferrie Salt and Ammonia.	Dry the precipitate.
	Fe ₃ O ₄	Ferroso-ferrie Oxide.	From a solution of the mixed Sulphates and Sodium Hydroxide. Occurs native also as Loadstone.	$\left\{ \begin{array}{l} \text{(a) } \text{FeSO}_4 + 2\text{NaHO} = \text{Na}_2\text{SO}_4 + \text{Fe}_2\text{HO} \\ \text{(b) } \text{Fe}_2(\text{SO}_4)_3 + 6\text{NaHO} = 3\text{Na}_2\text{SO}_4 + \text{Fe}_3\text{HO} \\ \text{(c) } \text{Fe}_2\text{HO} + \text{Fe}_3\text{HO} = 4\text{H}_2\text{O} + \text{Fe}_3\text{O}_4 \end{array} \right.$
	K ₂ FeO ₄	Potassium Ferrate.	Ferrie Oxide and Nitre heated.	FeO ₃ and H ₂ FeO ₄ have never been isolated.
	Fe ^{II} SO ₄	Ferrous Sulphate.	From Iron pyrites (Fe S ₂).	$\text{FeS}_2 + \text{Fe} + 4\text{O}_2 = 2\text{FeSO}_4$
Titanium	Fe ^{III} ₂ (SO ₄) ₃	Ferrie Sulphate.	Ferrous Sulphate, Sulphuric', and Nitric'.	$6\text{FeSO}_4 + 3\text{H}_2\text{SO}_4 + 2\text{HNO}_3 = 4\text{H}_2\text{O} + 2\text{NO} + 3\text{Fe}_2(\text{SO}_4)_3$
	Ti 50	Density 50	Titanium Potassio-Fluoride and Potassium.	

White,

Green, d

Red hyd

White, b

Reddish

In powder

With ice

K, F

Green, so

A buff co

Resemble

PROPERTIES.	TESTS.	
	FERROUS.	FERRIC.
White, soft, tough.		
Green, deliquescent crystals, oxydize rapidly in air.	1. Alkalies, Ammonia and Carbonates give.....	White becoming green then brown. Foxy red.
Red hydrated crystals, soluble in water and in alcohol.	2. Sulph-hydric'.....	No change. White (Sulphur.)
White, becomes dark green and then red on exposure.	3. Ammonium Sulphide.....	Black. Black.
Reddish brown ; occurs native as Hæmatite.	4. Potassium Ferrocyanide....	White turns blue. Blue.
	5. Potassium Sulphocyanide...	None Blood-red.
	6. Potassium Ferricyanide....	Blue Green.
	7. Tincture of Galls.....	None Blue black.
In powder or in octahedral crystals, magnetic.		
With ice cold water it forms a deep amethystine colored solution of K_2FeO_4 .		
Green, soluble crystals, called Copperas or <i>green vitriol</i> .		
A buff colored amorphous mass.		
Resembles Tin, forms 2 sets of salts also.	1. Tincture of Galls gives an orange precipitate. 2. Potassium Ferrocyanide gives a dark brown. 3. Borax and Titanic Oxide form a glass which is yellow while hot, but becomes violet in cooling.	

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Manganese	Mn 55	Density 7.13	Calcined Carbonate, Borax, Charcoal.	Packed in a crucible and fused by a red heat.
	MnO	Manganous Oxide.	Carbonate and Hydrogen gas.	Pass the gas over the heated Carbonate.
	Mn ₂ O ₄	Manganoso-manganic Oxide.	Native as Hausmannite.	Or heat MnO ₂ to whiteness in the air.
	Mn ₂ O ₃	Manganic Oxide.	Native.	Expose hydrated monoxide to the air.
	MnO ₂	Binoxide.	The most common natural form.	Called Pyrolusite.
	Mn ₃ O ₇	Varvicite.	A natural mineral.	
	MnCO ₃	Carbonate.	Bichloride and an Alkaline Carbonate.	Mix the solutions and it falls as a precipitate.
	K ₂ MnO ₄	Manganate of Potash.	Fuse Binoxide with Potash.	Manganic Acid has never been isolated.
	K ₂ Mn ₂ O ₈	Permanganate of Potash.	Manganate and water.	$3K_2MnO_4 + 2H_2O = MnO_2 + 4KHO + K_2Mn_2O_8$
Stannum	Sn (Tin) 113	Density 7.3	Found chiefly as Tin Oxide.	The ore is crushed and heated with coal; the Tin fuses out.
	H ₂ SnO ₃	Stannic Acid.	Alkaline Stannates and an acid.	

PROPERTIES.	TESTS.														
A reddish, brittle, lustrous metal, decomposes water.	<div>1. Alkalies, Ammonia and Carbonates give white precipitates, becoming brown.</div> <div>2. Sulph-hydric', no change.</div> <div>3. Ammonium Sulphide, a flesh colored Sulphide.</div> <div>4. Potassium Ferrocyanide, a white precipitate.</div> <div>5. With Borax and a blow-pipe, forms an amethystine-red bead in the outer flame, and none in the inner flame.</div> <div>6. Heated on Platinum foil with Sodium Carbonate it yields a green mass of Sodium Manganate.</div>														
A green powder ; a strong base.															
A neutral oxide.															
Brown or black ; a feeble base.															
Black ; a neutral oxide.															
Resembles MnO_2 , but is harder and more brilliant.															
An insoluble buff-colored or white powder ; when heated it loses CO_2 and absorbs O.															
A green saline mass, may be in crystals.															
Dark purple crystals. Condry's fluid is a solution of this salt.															
White ; when heated it oxydizes forming <i>putty powder</i> .															
There is also a Metastannic Acid ($H_{10}Sn_5O_{18}$).	<table><tr><td></td><td>STANNOUS.</td><td>STANNIC.</td></tr><tr><td>1. Alkalies, Ammonia and Carbonates.....</td><td>White.</td><td>White.</td></tr><tr><td>2. Sulph-hydric' and Ammonium Sulphide....</td><td>Dark brown.</td><td>Yellow.</td></tr><tr><td>3. Auric Chloride</td><td>Purple.</td><td>None.</td></tr></table>				STANNOUS.	STANNIC.	1. Alkalies, Ammonia and Carbonates.....	White.	White.	2. Sulph-hydric' and Ammonium Sulphide....	Dark brown.	Yellow.	3. Auric Chloride	Purple.	None.
	STANNOUS.	STANNIC.													
1. Alkalies, Ammonia and Carbonates.....	White.	White.													
2. Sulph-hydric' and Ammonium Sulphide....	Dark brown.	Yellow.													
3. Auric Chloride	Purple.	None.													

Names.	Formula, &c.	History, &c.	Prepared From.	Decompositions.
Uranium	U 120	Density 18.4	Decompose the Chloride with Potassium. Found in Uranite and Pitchblende.	These salts are used in Photography and in enamel painting.
	UO	Uranous Oxide.	U ₃ O ₄ and Hydrogen.	Heat the former in a stream of the latter gas.
	U ₂ O ₄	Uranoso-uranic Oxide.	Ignite the metal in air.	
	U ₂ O ₃	Uranic Oxide	Heat the Nitrate.	
	UCl ₃	Uranous Chloride.	Metal and Chlorine gas.	Heat the metal in the gas.
	U ₂ O ₂ Cl ₂	Uranic Oxychloride.	Uranous Oxide and Chlorine gas.	
Indium	In 74		Exists in Zinc blende.	It was discovered by spectrum analysis.
Nickel	Ni 58.8	Density 8.8	Found as an Arsenide.	Heat the Oxalate to a white heat.
Cobalt	Co 58.8	Density 8.5	Found associated with Nickel.	And obtained like that metal.
	Co(NO ₂) ₂	Cobaltous Nitrate.	Metal and Nitric'.	
	CoCl ₂	Cobaltous Chloride.	Oxide & Hydrochloric'.	

PROPERTIES.	TESTS.		
A black powder, or in fused white malleable globules, it forms Uranous and Uranic Salts.			
A brown powder, sometimes crystalline, dissolves in acids and forms green salts.		URANOUS.	URANIC.
A dark green soft powder.	1. Water forms solutions that are.....	Green	Yellow.
A yellowish powder—it unites with metals and forms salts called <i>Uranates</i> .	2. Caustic Alkalies give a.....	Red-brown	Yellow.
In dark-green regular octahedron crystals, forming an emerald-green solution with water.	3. Alkaline Carbonates give.....	Green	Yellow.
A yellow crystalline mass, soluble in water.	4. Ammonium Sulphide.....	Black	None.
Soft, lead-grey, blackens paper like lead.	5. Potassium Ferrocyanide.....		Red-brown.
White and malleable ; the salts are unimportant.	6. Borax and a Phosphorous salt with any salt of Uranium, will form a green glass.		
White, brilliant, tenacious : forms two sets of salts.	Indium gives 2 indigo-colored lines in the spectrum.		
Used in the laboratory in blow-pipe tests.	{ 1. Alkalies, Ammonia & Carbonates give a pale apple-green precipitate.		
Rose-colored crystals.	{ 2. Potassium Cyanide and Ferro-cyanide a green.		
	{ 3. Sulph-hydric' no change. (4) Ammonium Sulphide a black precipitate.		
		COBALTOUS.	COBALTIC.
	1. Solution of Potash gives a.....	Blue growing red.	Dark brown.
	2. Ammonia	Red grows brown.	Brownish red.
	3. Sodium & Ammonium Carbonate.	Pink.	Green.
	4. Potassium Ferrocyanide.....	Greyish green.	.....
	5. Potassium Cyanide.....	Yellowish brown.	.....
	6. Sulph-hydric'	No change.	.....
	7. Ammonium Sulphide.....	Black.	Black.

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Stibium	Sb 122	Density 6.8	Found as Sulphide.	Freed by fusion, &c., called Antimony.
	SbCl ₃	Antimonious Chloride.	Antimonious Sulphide and Hydrochloric'.	$Sb_2S_3 + 6HCl = 3H_2S + 2SbCl_3$
	SbCl ₅	Antimonic Chloride.	The metal, heat and Chlorine gas.	$Sb + 5Cl = SbCl_5$
	SbH ₃	Antimoniuretted Hydrogen. Stibine.	Zinc, Sulphuric', Antimonious Oxide.	
	Sb ₂ O ₃	Antimonious Oxide.	Antimonious Sulphide, Water and Soda Carbonate.	$2SbCl_3 + 3Na_2CO_3 = 6NaCl + 3CO_2 + Sb_2O_3$
	Sb ₂ O ₄	Tetroxide.	Native as Cervantite.	Or heat the metal in the air for some time.
	Sb ₂ O ₅	Antimonic Oxide.	Antimonic Anhydride.	Heat Antimonic Hydrate.
	HSbO ₃	Antimonic Acid.	Antimony and Nitric'.	
	H ₂ Sb ₂ O ₇	Metantimonic Acid.	Antimonic Chloride and Water.	$2SbCl_3 + 7H_2O = 10HCl + H_2Sb_2O_7$
	K ₂ H ₂ Sb ₂ O ₇	Potassium Hydrogen Metantimonate.	Potassium Antimonate & Potassium Hydrate.	Fuse together.
	KSbO ₃	Antimonate of Potash.	Antimony and Nitre.	Fuse together.
	Sb ₂ S ₃	Antimonious Sulphide.	Native.	Called Black Antimony.
	Sb ₂ S ₅	Antimonic Sulphide.	Tersulphide, Sodium Carbonate, Sulphur, and Lime Hydrate.	Boil in water and add diluted Sulphuric Acid and Sb ₂ O ₃ falls down (Golden Sulphuret).

METALS.

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PROPERTIES.	TESTS.
Bluish-white, lustrous, brittle, crystalline.	
A white crystalline mass, its solution is <i>Butter of Antimony</i> .	
A colorless volatile liquid.	
A gas, burns with a greenish flame.	
A white powder, acts as an acid and forms <i>Antimonites</i> , which are however very unstable.	1. Ammonium Sulphide gives an orange precipitate.
A grey-white powder, infusible.	2. Alkalies and Carbonates give white precipitates.
A straw-colored acid powder, insoluble in water.	3. Zinc and Iron reduce the salts to the metal, as a black powder.
A white powder, soluble, acid, monobasic.	4. SbH ₃ burns and deposits 2 rings on a plate held in the flame
It is dibasic and forms 2 series of salts, normal and acid Metantimonates.	soluble in Ammonium Sulphide, but not in a solution of Chlorinated Lime, nor in Nitric', which distinguishes it from Arseni-
Its solution is used as a test for Sodium, with which it gives a white granular precipitate, the only known insoluble salt of Soda.	uretted Hydrogen (AsH ₃).
These 2 acids resemble Metaphosphoric' (HPO ₃) and Pyrophosphoric' (H ₂ P ₂ O ₇).	5. Fused with Charcoal and Sodium Carbonate, a brittle globule of
Lead-grey, brittle, crystalline.	Antimonium appears, and the Charcoal is covered for some
A golden-yellow, flocculent powder.	distance with the Oxide (Sb ₂ O ₃).

NAMES.	FORMULÆ, &c.		HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Arsenicum	As	75	Density 5.7	Arsenious' and Carbon. Native as Sulphides, &c.	$As_2O_3 + 3C = 3CO + As_2$
	AsH_3		Arseniuretted Hydrogen.	Zinc, Sulphuric', and As_2O_3	
	As_2O_3		Arsenious Anhydride.	Obtained while roasting ores of Tin, &c.	The As_2O_3 volatilizes and is purified by re-sublimation.
	As_2O_5		Arsenic Anhydride.	Evaporate to dryness Arsenic Acid.	
	H_3AsO_4		Arsenic Acid.	Arsenious Anhydride and dilute Nitric'.	$As_2O_3 + 2HNO_3 + 2H_2O = N_2O_5 + 2H_3AsO_4$
Bismuth	Bi	210	Density 9.9	Native.	Simple exposure of its ore to heat procures it. It forms bi-, tri- and quinquivalent salts.
Vanadium	V	51.2		Combined with Lead and Iron ores.	Heat Vanadium Nitrite to whiteness in Ammonia gas.
Tantalum	Ta	182		Fluo-tantalate of Potassium and Potassium.	It occurs as Tantalite and Yttro-tantalite.
Niobium	Nb	94		Associated with Uranium, &c.	Prepared like Tantalum.

PROPERTIES.	TESTS.
Steel-grey, crystalline, brilliant, volatile, tarnishes in air.	1. Ammonio-Nitrate of Silver gives a yellow precipitate $\text{Ag}_2\text{As}_2\text{O}_4$.
A poisonous gas, burns, and furnishes 3 rings on a cold plate.	2. Ammonio-Sulphate of Copper gives a green precipitate, Scheele's green.
White, heavy porcelain-like masses, or in crystals.	3. Sulphuretted Hydrogen acidulated with Hydrochloric' gives yellow As_2S_3 .
A white deliquescent substance.	4. Zinc, Sulphuric' and white Arsenic give Arseniuretted Hydrogen, which burns and furnishes 3 rings on a plate held in the flame, which are soluble in Nitric' and in a solution of Chlorinated Lime, but not in Ammonium Sulphide (Marsh's Test).
A solution which gives a chocolate-red with Silver Nitrate.	5. <i>Reinsch's Test</i> .—Copper placed in an acidulated solution of white Arsenic becomes coated with metallic Arsenicum.
A reddish-white crystalline metal, brittle, volatile, and burns with a blue flame.	6. <i>Reduction Test</i> .—Use the Berzelius test tube with <i>black flux</i> , <i>i. e.</i> Charcoal and dried Sodium Carbonate, metallic As is formed on heating the tube and condenses as a ring on the cool part.
<i>Characteristic Test</i> .—Sulphuretted Hydrogen gives a black precip.	7. The metal is volatile and emits an alliaceous odor.
White, brittle, lustrous, forms 4 oxides.	Heated with Borax and a Phosphate it forms a yellow bead.
Black and burns with a bright light.	1. Sulphuric' and Hydrochloric' give white precipitates. (2) Infusion of Galls, yellow.
Black powder; if heated oxydizes with incandescence.	3. Potassium Ferrocyanide, yellow. (4) Ferricyanide a white precipitate.
	5. The Chloride with zinc gives a blue color. (6) Borax and the blow-pipe forms a transparent glass that becomes opaque by blowing.
	1. Hydrochloric' gives a white precipitate.
	2. Ammonium Chloride a white precipitate.
	3. Potassium Ferrocyanide a red precipitate.
	4. Potassium Ferricyanide a bright yellow.
	5. Infusion of Galls an orange-red precipitate.
	6. Borax & the blow-pipe produces a bead, that becomes opaque in blowing.

NAMES.	FORMULÆ, &c.	HISTORY, &c.	PREPARED FROM.	DECOMPOSITIONS.
Chromium	Cr 52.5	Density 7	Heat Carbonate or Sesquioxide.	
	CrO ₃	Chromic Anhydride.	Potassium Bichromate and Sulphuric'.	$K_2Cr_2O_7 + H_2SO_4 = K_2SO_4 + H_2O + 2CrO_3$
	H ₂ CrO ₄	Chromic Acid.	Chromic Anhydride and Water.	$CrO_3 + H_2O = H_2CrO_4$ it is bibasic.
	K ₂ CrO ₄	Potassium Chromate.	Chrome Iron ore and Potassium Carbonate heated.	Treat the residue with water, K ₂ CrO ₄ crystallizes out.
	K ₂ Cr ₂ O ₇	Potassium Bichromate.	Chromate & Sulphuric'.	$2K_2CrO_4 + H_2SO_4 = K_2SO_4 + H_2O + K_2Cr_2O_7$
Wolfram	W 184	Tungsten. Density 17.4	Heat Tungstic Oxide in Hydrogen.	It requires a very high temperature for fusion.
Molybdenum	Mo 92	Density 8.6	Heat the Oxide with Charcoal.	Exists naturally as Sulphide and Lead Molybdate.

-2CrO₃

CrO₃, crys-

-K₂Cr₂O₇

ature for

and Lead

PROPERTIES.	TESTS.		
Is in fine powder or in small crystals, extremely hard and almost infusible.	<ol style="list-style-type: none"> 1. Sulphuretted Hydrogen gives... 2. Ammonium Sulphide 3. Caustic Alkalies 4. Ammonia 5. Carbonates 6. Salammoniac and Ammonia 7. Tungstic Acid 8. Auric Chloride 9. Barium Salts 10. Lead Salts 11. Mercurous Salts 12. Silver Salts 	CHROMOUS.	CHROMIC.
Crimson, deliquescent needles.		No change. Black.	No change. Greyish-green.
It bleaches and decomposes immediately with organic matter.		Blue becomes green	Greyish-green.
Lemon-yellow prisms.		Blue gets red.	Green.
In red tables or short prisms.		Blue.	.....
A dark grey powder; exists as Tungstate of Iron and Cobalt.		Metallic Gold.	.....
White, brittle, infusible.		.....	Pale yellow.
		.....	Bright yellow.
		.....	Brick-red.
		.....	Crimson.
		13. Borax and blow-pipe yield an emerald-green glass.	
		1. Zinc and Hydrochloric', or Sulphuric', or Phosphoric', or Oxalic', or Acetic' yield a beautiful blue Oxide.	
		2. Ammonium Sulphide acidulated gives a light brown.	
		3. Sulphuretted Hydrogen acidulated gives a blue color.	
		4. Potassium Ferrocyanide acidulated gives a brown precipitate.	
		5. Acids give white or yellow precipitates.	
		MOLYBDOS.	MOLYBDIC.
	1. Solution in acids	Almost black	Reddish-brown
	2. Sulphuretted Hydrogen	Brown-black	Brown-black.
	3. Alkalies and Carbonates	Brown-black	Brown-black.
	4. Potassium Ferrocyanide	Dark brown	Brown-black.
	5. Sodium Phosphate	White	White.
	6. Heated in air .....	.....	Blue.
	7. Heated with Zinc .....	.....	Black.

Variations in the Quantivalence of the Elementary bodies.—Notwithstanding the classification of the non-metallic and metallic radicals into *univalent* and *multivalent* or *polygenic groups*, which has been hitherto followed throughout this work ; it becomes necessary to remark that with the exception of the monatomic class which are usually univalent, all the other radicals are apt to exhibit varying degrees of Quantivalence. The series of Nitrogen Oxides afford an illustration of this. From their formulæ N_2O , N_2O_2 , N_2O_3 , N_2O_4 , N_2O_5 , we notice that the Nitrogen may rank in any class from a Monad to a Pentad inclusive. Carbon which is tetrad in CH_4 and in CO_2 , is only dyad in CO ; Sulphur is Hexad in SO_3 , tetrad in SO_2 , and dyad in SH_2 ; Iron is sometimes dyad, at others triad and rarely hexad. Many more instances might be adduced in illustration of this tendency of most elementary bodies to form more than one set of compounds, but those mentioned are sufficient to shew us that too great reliance must not be placed on the representations of atomic structure which have hitherto been advanced by scientific chemists. Yet, at the same time, each elementary radical appears to have a favourite quantivalence, when its compounds are found to be more stable and permanent ; and all others which it may otherwise form, shew a tendency on the slightest excitation, to assume that proportion or condition.

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O₂, N₂O₄,
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ORGANIC CHEMISTRY.

Though the term Organic Chemistry is not now admitted in the sense in which it was at one time employed, yet it is still used to designate a more complicated set of compounds than those which have hitherto been described. Many of these organic compounds can now be prepared artificially by ordinary chemical manipulations, without the aid of plant or animal life, which was at one time supposed to be so essential to their production, hence the distinction formerly drawn between organic and inorganic chemistry is now fast disappearing. From the fact that these compounds nearly always contain Carbon as one of their constituents, this department of the science has been called the *Chemistry of the Carbon Compounds*.

These organic substances from being more complex in constitution, are more subject to decomposition and to transformation than the Inorganic. Thus, we find that the application of *heat* will produce many different results with them, varying much and in proportion to the temperature to which they are exposed; thus, we procure gases, vapors, oleaginous, ethereal and empyreumatic matters; while with chemical reagents the products will be found to be equally diversified. *Oxygen* for instance may act in four different modes on an organic compound. 1st. By simply oxydizing the substance; 2nd. By withdrawing Hydrogen from it; 3rd. By not only withdrawing the H, but also usurping its place; 4th. By extracting both Carbon and Hydrogen from it. *Chlorine, Iodine, and Bromine*, act on such bodies exactly in the same way as *Oxygen* does. *Nitric Acid* also produces different effects; thus, it sometimes unites directly with the compound as with a metal; at other times it withdraws Hydrogen and deposits in its place NO, (or Nitryl); or it may simply oxydize the compound. *Alkalies* may unite directly with the substance, or may withdraw Hydrogen and oxydize the product, or if it

contains Chlorine it may remove and appropriate it; or double decomposition may take place between the compound and the salt employed. *Hydrogen, Potassium, Sodium* and other *reducing agents*, withdraw Oxygen, Chlorine, Iodine and Bromine from them, sometimes substituting Hydrogen. *Sulphuric Anhydride, Phosphoric Anhydride, Strong Sulphuric Acid* and other *Dehydrating Chemicals* remove one or more molecules of H_2O from their constituents.

In describing the composition of chemical bodies, two kinds of formulæ may be employed:—the *Empirical* which gives merely the atomic composition of the molecule, example C_2H_6O or common Alcohol; and the *Rational* which not only does this, but shews at once its real character and its proper position in relation to the other organic compounds; thus, Alcohol is more properly written C_2H_5HO , or Ethyl Hydroxide. Both formulæ are however correct, but the latter is more explicit.

The atoms of Carbon possess the property of *uniting among themselves* in a much higher degree than those of any other element, and this accounts for the multiplicity of the carbon compounds as compared with those of any other elementary body. Carbon is a tetrad and has therefore 4 bonds requiring satisfaction. In the compound Methane $H-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}}-H$ we find every bond provided for and this constitutes a *Saturated Hydrocarbon* compound. But four atoms of any other monad will accomplish this end as well, and the following *substitution products* can be obtained by suitable means from CH_4 by the action of Chlorine.



Now when 2 atoms of tetravalent Carbon unite together, the union is effected thus $\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}}-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}}-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}}-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}}$ 2 of the bonds being employed in uniting with each other and a new *radical* (or group of atoms) is formed which presents only 6 bonds to be satisfied or to form a

saturated compound, as occurs with Ethane C_2H_6 . If 3 atoms unite then 4 bonds are employed in the union of the Carbon atoms; thus, $\text{—}\overset{\text{O}}{\underset{\text{O}}{\text{C}}}\text{—}\overset{\text{O}}{\underset{\text{O}}{\text{C}}}\text{—}\overset{\text{O}}{\underset{\text{O}}{\text{C}}}\text{—}$ and the resulting molecule (or new radical) presents only 8 bonds for saturation, a condition which is met with in the substance known as Propane C_3H_8 . These examples can be multiplied *ad infinitum*.

Hence CH_4 (Methane) is taken as the type of the *Monocarbon Series* of *Saturated Hydrocarbon Compounds*; C_2H_6 (Ethane) as the type of the *Dicarbon Series*; C_3H_8 (Propane) as that of the *Tricarbon Series*, &c.

There are however other groups of organic compounds in which all the combining bonds are not satisfied, such as Methene $H\text{—}\overset{\text{O}}{\underset{\text{O}}{\text{C}}}\text{—}H$, and Ethene $H\text{—}\overset{\text{O}}{\underset{\text{O}}{\text{C}}}\text{—}\overset{\text{O}}{\underset{\text{O}}{\text{C}}}\text{—}H$, these are therefore called in contradistinction to the before-mentioned series, *Non-saturated Compounds* and these $\begin{matrix} H & H \end{matrix}$ latter will always unite directly with other elements in such quantities as will fill up the vacant combining bonds to become saturated; thus, CH_3 and C_2H_5 will unite directly with Cl_2 to form saturated compounds; whilst, on the other hand, we find it impossible to obtain a combination of Cl with CH_4 , or C_2H_6 , because they are already saturated.

No less than 16 artificially prepared members of the saturated hydrocarbon series, containing from 1 to 16 atoms of C combined with a saturating quantity of H , are known, and each member of this series forms a starting point for a number of peculiar derivatives, all containing a common constituent and all exhibiting a family likeness.

The compounds derived from each of these series of mono-, di-, tri-, tetra-, and higher carbon-groups may advantageously be compared with those of the inorganic metals, and each different carbon series may be supposed to contain a group of atoms of C and H , which plays the same part in their compounds that the metal does in the metallic salts, and to this group of C and H the name of *Compound radical* has been given. The following is a list of the compound radicals of the saturated hydrocarbons and of some of their principal derivatives.

RADICALS.		Saturated Hydrocarbons or Hydrides.	OXIDES OR ETHERS.	HYDROXIDES OR ALCOHOLS.	ALDEHYDES.	ACIDS.
Methyl.....	(CH ₃) ₂	CH ₃ H	(CH ₃) ₂ O	CH ₃ HO	CH ₃ O	CH ₃ O ₂ Formic'.
Ethyl.....	(C ₂ H ₅) ₂	C ₂ H ₅ H	(C ₂ H ₅) ₂ O	C ₂ H ₅ HO	C ₂ H ₄ O	C ₂ H ₄ O ₂ Acetic'.
Propyl.....	(C ₃ H ₇) ₂	C ₃ H ₇ H	(C ₃ H ₇) ₂ O	C ₃ H ₇ HO	C ₃ H ₆ O	C ₃ H ₆ O ₂ Propionic'.
Butyl.....	(C ₄ H ₉) ₂	C ₄ H ₉ H	(C ₄ H ₉) ₂ O	C ₄ H ₉ HO	C ₄ H ₈ O	C ₄ H ₈ O ₂ Butylic'.
Amyl.....	(C ₅ H ₁₁) ₂	C ₅ H ₁₁ H	(C ₅ H ₁₁) ₂ O	C ₅ H ₁₁ HO	C ₅ H ₁₀ O	C ₅ H ₁₀ O ₂ Valerianic'.
Hexyl.....	(C ₆ H ₁₃) ₂	C ₆ H ₁₃ H	(C ₆ H ₁₃) ₂ O	C ₆ H ₁₃ HO	C ₆ H ₁₂ O	C ₆ H ₁₂ O ₂ Caproic'.
Heptyl.....	(C ₇ H ₁₅) ₂	C ₇ H ₁₅ H	(C ₇ H ₁₅) ₂ O	C ₇ H ₁₅ HO	C ₇ H ₁₄ O	C ₇ H ₁₄ O ₂ (Enanthylic'.
Octyl.....	(C ₈ H ₁₇) ₂	C ₈ H ₁₇ H	(C ₈ H ₁₇) ₂ O	C ₈ H ₁₇ HO	C ₈ H ₁₆ O	C ₈ H ₁₆ O ₂ Capric'.
Nonyl.....	(C ₉ H ₁₉) ₂	C ₉ H ₁₉ H	(C ₉ H ₁₉) ₂ O	C ₉ H ₁₉ HO	C ₉ H ₁₈ O	C ₉ H ₁₈ O ₂ Pelargonic'.
Decatyl.....	(C ₁₀ H ₂₁) ₂	C ₁₀ H ₂₁ H	(C ₁₀ H ₂₁) ₂ O	C ₁₀ H ₂₁ HO	C ₁₀ H ₂₀ O	C ₁₀ H ₂₀ O ₂ Rutic'.
Undecyl.....	(C ₁₁ H ₂₃) ₂	C ₁₁ H ₂₃ H	(C ₁₁ H ₂₃) ₂ O	C ₁₁ H ₂₃ HO	C ₁₁ H ₂₂ O	C ₁₁ H ₂₂ O ₂
Dodecyl.....	(C ₁₂ H ₂₅) ₂	C ₁₂ H ₂₅ H	(C ₁₂ H ₂₅) ₂ O	C ₁₂ H ₂₅ HO	C ₁₂ H ₂₄ O	C ₁₂ H ₂₄ O ₂ Lauric'.
Tridecyl.....	(C ₁₃ H ₂₇) ₂	C ₁₃ H ₂₇ H	(C ₁₃ H ₂₇) ₂ O	C ₁₃ H ₂₇ HO	.....	.....
Quatuordecyl.....	(C ₁₄ H ₂₉) ₂	C ₁₄ H ₂₉ H	(C ₁₄ H ₂₉) ₂ O	C ₁₄ H ₂₉ HO	C ₁₄ H ₂₈ O	C ₁₄ H ₂₈ O ₂ Myristic'.
Quindecyl.....	(C ₁₅ H ₃₁) ₂	C ₁₅ H ₃₁ H	(C ₁₅ H ₃₁) ₂ O	C ₁₅ H ₃₁ HO	C ₁₅ H ₃₀ O	.....
Cetyl.....	(C ₁₆ H ₃₃) ₂	C ₁₆ H ₃₃ H	(C ₁₆ H ₃₃) ₂ O	C ₁₆ H ₃₃ HO	.....	C ₁₆ H ₃₂ O ₂ Palmitic'.
.....	.....	.....	.....	.....	.....	C ₁₇ H ₃₄ O ₂ Margaric'.
.....	.....	.....	.....	.....	.....	C ₁₈ H ₃₆ O ₂ Stearic'.
.....	.....	.....	.....	.....	.....	C ₂₀ H ₄₀ O ₂ Arachic'.
.....	.....	.....	.....	.....	.....	C ₂₂ H ₄₄ O ₂ Behenic'.
Ceryl.....	(C ₂₇ H ₅₅) ₂	.....	.....	C ₂₇ H ₅₅ HO	.....	C ₂₇ H ₅₄ O ₂ Cerotic'.
Metyl.....	(C ₃₀ H ₆₁) ₂	.....	.....	C ₃₀ H ₆₁ HO	.....	C ₃₀ H ₆₀ O ₂ Melissic'.

Wherever vacancies occur in this table it indicates that such compounds have not yet been isolated. It will be observed that the saturated compounds are regarded as *Hydrides* of the compound radicals, the *oxides* are known as *Ethers*, the *hydroxides* as *Alcohols*, their compounds with Acetic' and other acids are called *Ethereal Salts*, each furnishes an *Aldehyde* and one or more *acids*.

Saturated Hydro-Carbons may however be deprived of one or more molecules of H, and give rise to new *homologous* series; thus, Methane CH_4 may become CH_3 , Ethane C_2H_6 is converted into C_2H_5 , Propane C_3H_8 forms C_3H_7 , &c., &c., these are therefore molecules of *unsaturated hydro-carbons*, having two bonds free and uncombined, and on this account they act as Dyads. And again C_2H_4 , C_3H_6 and C_4H_8 may each by appropriate means lose another molecule of H, and other new series arise, viz.:— C_2H_3 , C_3H_5 , C_4H_7 , each being a quadrivalent or tetrad radical.

The following table will better illustrate these series, it includes however only the first 6, together with the names that have been proposed for each by Dr. Hofman:—

1st Series PARAFFINS.	2nd Series. OLEFINS.	3rd Series.	4th Series.	5th Series.	6th Series.	7th Series.
CH_4 Methane.	CH_3 Methene.					
C_2H_6 Ethane.	C_2H_5 Ethene.	C_2H_3 Ethine.				
C_3H_8 Propane.	C_3H_7 Propene.	C_3H_5 Propine.	C_3H_3 Propone.			
C_4H_{10} Quartane.	C_4H_9 Quartene.	C_4H_7 Quartine.	C_4H_5 Quartone.	C_4H_3 Quartune.		
C_5H_{12} Quintane.	C_5H_{11} Quintene.	C_5H_9 Quintine.	C_5H_7 Quintone.	C_5H_5 Quintune.	C_5H_3	
C_6H_{14} Sextane.	C_6H_{13} Sextene.	C_6H_{11} Sextine.	C_6H_9 Sextone.	C_6H_7 Sextune.	C_6H_5	C_6H_3

If the preceding table be read from left to right, each line will present an *isologous* series, each molecule differing from the one preceding it by H_2 less, but if read from above downwards then it affords an example of a *homologous* series, where each differs from its immediate neighbours in CH_4 .

It has been shewn already that saturated hydro-carbons may give up one or more of their H atoms in exchange for another element; thus, from Methane CH_4 we may get CH_3Cl , CH_2Cl_2 , $CHCl_3$, and CCl_4 , and these *substitution compounds* may be regarded as being formed of Cl with radicals CH_3^I , CH_2^{II} , CH^{III} , and C^{IV} , which are monad, dyad, triad and tetrad respectively: *the quantivalence depending altogether upon the number of H atoms withdrawn from the original saturated molecule.* Those of even quantivalence, dyads and tetrads, contain even numbers of H atoms, but those of uneven quantivalence, monads, triads and pentads, contain odd numbers of H atoms, and are supposed to exist as double molecules, as seen in Methyl $(CH_3)_2$, Ethyl $(C_2H_5)_2$, &c. These latter are distinguished by names ending in *yl*. The annexed table will illustrate these peculiarities regarding the quantivalence, as well as the manner in which these compounds are named.

CH_4 Methane.	$(CH_3)^I$ Methyl.	$(CH_2)^{II}$ Methene.	$(CH)^{III}$ Methenyl.				
C_2H_6 Ethane.	$(C_2H_5)^I$ Ethyl.	$(C_2H_4)^{II}$ Ethene.	$(C_2H_3)^{III}$ Ethenyl.	$(C_2H_2)^{IV}$ Ethine.	$(C_2H)^V$ Ethinyl.		
C_3H_8 Propane.	$(C_3H_7)^I$ Propyl.	$(C_3H_6)^{II}$ Propene.	$(C_3H_5)^{III}$ Propenyl.	$(C_3H_4)^{IV}$ Propine.	$(C_3H_3)^V$ Propinyl.	$(C_3H_2)^{VI}$ Propone.	$(C_3H)^{VII}$ Proponyl.

All the ORGANIC COMPOUNDS may be arranged into the following 20 groups:

- | | |
|--|--|
| Class 1. Hydro-carbons with even number of Hydrogen atoms. | Class 5. Mercaptans or Sulphur Alcohols. |
| Class 2. Alcohols. | Class 6. Selenium Alcohols |
| Class 3. Haloid Ethers. | Class 7. Sulphur and Selenium Ethers. |
| Class 4. Oxygen Ethers. | Class 8. Compound Ethers. |

Class 9. Aldehydes.

Class 10. Organic Acids.

Class 11. Acid Halides.

Class 12. Acid Oxides.

Class 13. Ketones.

Class 14. Amines.

Class 15. Alcoholic Ammonium compounds.

Each of these classes we will now proceed to describe :

1st Class.—HYDRO-CARBONS WITH EVEN NUMBERS OF HYDROGEN ATOMS; yet it must not be forgotten that these are often regarded as Hydrides of organic radicals containing uneven numbers of H atoms; thus, CH_4 may be considered to be CH_3H . Now let us turn again to Dr. Hofman's table of the Hydro-carbons at page 75, and examine separately the various series which it presents to us :—

1st Series.— $\text{C}_n\text{H}_{2n+2}$ * or Paraffins (*parum affinis*) which are all saturated hydro-carbons, and owe their name to the fact that from being saturated they show no tendency to unite with other substances. No less than 16 of the paraffins have been prepared, containing from 1 to 16 atoms of Carbon in each molecule; many of them exist naturally in both American and other mineral oils; they are :—

(1) Methane CH_4
(2) Ethane C_2H_6
(3) Propane C_3H_8

(4) Quartane C_4H_{10}
(5) Quintane C_5H_{12}
(6) Sextane C_6H_{14}

(7) Septane C_7H_{16}
(8) Octane C_8H_{18}
(9) Nonane C_9H_{20}

(10) Decane $\text{C}_{10}\text{H}_{22}$
(11) Undecane $\text{C}_{11}\text{H}_{24}$
(12) Duodecane $\text{C}_{12}\text{H}_{26}$

(13) Tridecane $\text{C}_{13}\text{H}_{28}$
(14) Quatuordecane $\text{C}_{14}\text{H}_{30}$
(15) Quindecane $\text{C}_{15}\text{H}_{32}$
(16) Sexdecane $\text{C}_{16}\text{H}_{34}$

The first four of these are gases, the rest are liquids, whose boiling points and specific gravities rise as the molecular weight increases; though natural productions yet they can be prepared artificially;

1st. By the action of Zinc on Alcoholic Iodides; 2nd. By the dry distillation of Boghead and Cannel coal, &c.

* In a formula like this $\text{C}_n\text{H}_{2n+2}$ the n stands for any number of Carbon atoms.

2nd Series.— C_nH_{2n} or Olefines; these are all exact multiples of CH_2 ; they are 13 in number :—

Methene CH_2	Quartene C_4H_8	Septene C_7H_{14}	Decene $C_{10}H_{20}$	Trigintene $C_{30}H_{60}$
Ethene C_2H_4	Quintene C_5H_{10}	Octene C_8H_{16}	Sexdecene $C_{16}H_{32}$	.....
Propene C_3H_6	Sextene C_6H_{12}	Nonene C_9H_{18}	Septavigintene $C_{27}H_{54}$	.....

The higher compounds of this series are solid, the lower ones are gaseous, and the intermediate are liquid, and their boiling points rise also with the increase of the Carbon atom in their constitution. They may be prepared by decomposing nascent Paraffins by the action of Zinc or Sodium on Alcoholic Iodides, or by decomposing at a red heat Butyrates, Acetates, &c.

3rd Series.— C_nH_n —9. Five only of these have been procured; they are :—

Ethine C_2H_2	Propine C_3H_4	Quartine C_4H_6	Quintine C_5H_8	Sextine C_6H_{10}
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The first two are gases, the others are liquids. They may be prepared by heating Sodium Ethylate with Bromides of the Olefine derivatives.

4th Series.— C_nH_{2n-4} . Quintone C_5H_6 is the only known compound of this series; and certain volatile oils found ready formed in some particular plants, called Terpenes, $C_{10}H_{16}$, are also included under this head.

Quintone is a liquid and may be prepared from Alcoholic Potash with Quintine Dibromide; it is both sexvalent and tetravalent.

Terpenes are found more especially in Coniferous and Aurantiaceous plants; they include Oils of Turpentine, Bergamot, Lemon, Orange, Caraway, Cloves, Juniper, Thyme and many others.

5th Series.— C_nH_{2n-6} or Aromatic Hydro-carbons. Six only have been prepared, they are :—

Benzene C_6H_6	Toluene C_7H_8	Xylene C_8H_{10}	Cumene C_9H_{12}	Cymene $C_{10}H_{14}$	Amylxylyene $C_{11}H_{16}$
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Except the last they may all be procured by fractional distillation from the lighter oil obtained during the destructive distillation of coal; they are all liquids.

6th Series.— C_nH_{2n} —8. Two only of these have been prepared, viz.: Phenylene C_6H_4 , and Cinnamene C_8H_8 ; little is known concerning the first, but the latter is an oil and exists in Storax.

7th Series.— C_nH_{2n} —10. Only two of these are supposed to have been separated and they are not yet named.

8th Series.— C_nH_{2n} —12. Naphthalene $C_{10}H_8$ only has been procured; it is unimportant.

9th Series.— C_nH_{2n} —14. Diphenyl $C_{12}H_{10}$ and Dibenzyl $C_{14}H_{14}$ are alone known of this series, both are solids.

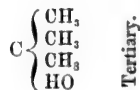
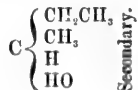
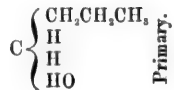
10th Series.— C_nH_{2n} —16. Stilbene $C_{14}H_{12}$ only is prepared; it is in mother-of-pearl-like plates.

11th Series.— C_nH_{2n} —18. Anthracene $C_{14}H_{10}$ is prepared by the dry distillation of coal, it is in small micaceous plates.

12th Series.— C_nH_{2n} —24. Chrysene $C_{18}H_{12}$, heat Diphenyl in a tube with H gas, it is in yellow crystalline plates.

Class II.—ALCOHOLS; these are organic compounds composed of hydro-carbon radicals (hence called Alcohol radicals) combined with (HO) Hydroxyl. The term Alcohol was at one time applied exclusively to Spirits of Wine, but is now used to designate a numerous class of organic compounds, which differ greatly from each other both in appearance and in properties, but yet they resemble one another however, in being all saturated hydro-carbons in which one or more of the H atoms have been replaced by (HO) Hydroxyl; and as these radicals differ from each other in their quantivalence, so we may have *monatomic, diatomic, triatomic and polyatomic* Alcohols, according to the number of (HO) Hydroxyl molecules they contain; thus, from Propane C_3H_8 three Alcohols may be procured: $(C_3H_7)^I$ (HO) or Propyl Alcohol, which is monatomic; $(C_3H_6)^{II}$ (HO)₂, Propene Alcohol, which is diatomic; and $(C_3H_5)^{III}$ (HO)₃ or Propenyl Alcohol, which is triatomic.

Alcohols may also be divided into *primary, secondary* or *tertiary* according as the atom of Carbon that is combined with the Hydroxyl is also directly united with 1, 2 or 3 other carbon atoms; thus:



SUBSTANCES.	FORMULÆ.	SYNONYMS.	PREPARED FROM.	PROCESS AND DECOMPOSITIONS.
Methyl Alcohol	$\text{CH}_3(\text{HO})$	Methyl Alcohol. Wood Spirit. Hydroxymethane. Carbinol.	(1) Oil of Wintergreen and solution of Potash. (2) Destructive distillation of wood.	(1) $\text{C}_2\text{H}_5\text{O}_2, \text{HCH}_3 + \text{KHO} = \text{KHC}_2\text{H}_5\text{O}_2 + \text{CH}_3(\text{HO})$ (2) It comes over first on distilling wood; add Lime, which forms Pyrolignite, and distill.
	CH_3O_2	Formic Acid.	Wood Spirit and Air.	$\text{CH}_3\text{HO} + \text{O}_2 = \text{H}_2\text{O} + \text{CH}_3\text{O}_2$
	CH_3Cl	Methyl Chloride.	Wood Spirit, Sulphuric and Sodium Chloride.	(a) $\text{CH}_3\text{HO} + \text{H}_2\text{SO}_4 = \text{H}_2\text{O} + \text{CH}_3\text{H}_2\text{SO}_4$ (b) $\text{CH}_3\text{HSO}_4 + \text{NaCl} = \text{NaHSO}_4 + \text{CH}_3\text{Cl}$
	CH_3I	Methyl Iodide.	Wood Spirit, Phosphorus and Iodine.	Prepared by distillation.
	$(\text{CH}_3)_2\text{O}$	Methyl Oxide or Ether.	Wood Spirit and Sulphuric.	(a) $\text{CH}_3\text{HO} + \text{H}_2\text{SO}_4 = \text{H}_2\text{O} + \text{CH}_3\text{H}_2\text{SO}_4$ (b) $\text{CH}_3\text{HSO}_4 + \text{CH}_3\text{HO} = \text{H}_2\text{SO}_4 + (\text{CH}_3)_2\text{O}$
	CH_3NO_2	Methyl Nitrate.	Wood Spirit, Sulphuric & Potassium Nitrate.	Distill, no heat is required.
	CH_3HS	Sulph-hydrate. Methyl Mercaptan.	Calcium Methyl-sulphate and Potassium Sulph-hydrate.	$\text{Ca}(\text{CH}_3)_2(\text{SO}_4)_2 + 2\text{KHS} = \text{K}_2\text{SO}_4 + \text{CaSO}_4 + 2\text{CH}_3\text{HS}$
	$\text{CH}_3\text{H}_2\text{SO}_4$	Acid Methylsulphate. Methylsulphuric Acid. Sulphomethylic Acid.	Wood Spirit and Sulphuric.	$\text{CH}_3\text{HO} + \text{H}_2\text{SO}_4 = \text{H}_2\text{O} + \text{CH}_3\text{HSO}_4$

C₂H₄O₂ing wood ;
ignite, andH₂, H₂SO₄,
+ CH₃ClH₂, H₂SO₄,
+O₂ + CaSO₄SO₂

PROPERTIES, &c.	REMARKS AND TESTS.
It is a colorless fluid, odor peculiar, taste unpleasant, it burns, and is soluble in water, sp. gr. 0.798; Caustic Baryta, Calcium Chloride, Potassium and Sodium dissolve in it.	The Oil of Wintergreen consists of Acid Methyl Salicylate. <i>To detect this Spirit in Tinctures, Ethers, &c.</i> —Distill off a small quantity with a little Potash Carbonate to neutralize any acid present, then add a few drops of a solution of Permanganate of Potash, if it does not become colored within 10 minutes it is pure.
A clear colorless fuming liquid, crystallizes below 0°C in large brilliant plates; sp. gr. 1.235, odor penetrating.	It reduces the salts of Gold, Platinum, Mercury and Silver. Exists naturally in Ants, Caterpillars and in stinging Nettles. The poison of the Wasp and Bee is said to be this acid.
A colorless gas, odor peculiar, taste sweet, unliquifiable, burns with a pale flame, greenish at the edges.	May be collected over water.
A colorless feebly combustible liquid, insoluble in water, sp. gr. 2.237, boils at 40°C. (111°F.)	
An unliquifiable colorless gas, odor ethereal, sp. gr. 1.617, this gas must be collected over Mercury.	It burns with a pale flame and a feeble light.
A colorless liquid, odor ethereal, sp. gr. 1.182, boils at 66°C. (151° F.)	Its vapor heated to 150°C. (302°F.) detonates violently.
A liquid, having a very offensive odor; it is lighter than water.	1. Lead Acetate gives a yellow precipitate. 2. Mercuric Oxide produces a white precipitate.
May be obtained as a sour syrupy liquid, or in minute acicular crystals, soluble in water and in alcohol—but this preparation is easily decomposed and is very unstable.	

SUBSTANCES.	FORMULÆ, &c.	SYNONYMS.	PREPARED FROM.	PROCESS AND DECOMPOSITIONS.
Ethyl Alcohol.	$C_2H_5(HO)$	Alcohol. Ethane Hydroxyl. Methyl Carbinol.	Glucose, Water, and a ferment.	$C_6H_{12}O_6 = 2CO_2 + 2C_2H_5HO$
	C_2H_4O	Aldehyde.	Potassium Acetate and Potassium Formate.	$KC_2H_3O_2 + KCHO_2 = K_2CO_3 + C_2H_4O$
	$C_2H_4O_2$	Acetic Acid.	Alcohol, Platinum black.	$C_2H_5HO + O_2 = H_2O + C_2H_4O_2$
	$(C_2H_5)_2O$	Oxide or Ether.	Alcohol and Sulphuric'.	(a) $C_2H_5HO + H_2SO_4 = H_2O + C_2H_5HSO_4$ (b) $C_2H_5HSO_4 + C_2H_5HO = H_2SO_4 + (C_2H_5)_2O$
	$C_2H_5NO_3$	Nitrate.	Alcohol, Urea, Nitric'.	The vapor explodes if strongly heated.
	$C_2H_5NO_2$	Nitrite.	Alcohol, Nitric'.	
	C_2H_5HS	Mercaptan. Ethyl Sulph-hydrate.	Potassium Sulph-hydrate Calcium Ethylsulphate.	$Ca(C_2H_5)_2(SO_4)_2 + 2KHS = K_2SO_4 + CaSO_4 + 2C_2H_5HS$
	$C_2H_5HSO_4$	Sulpho-ethylic Acid.	Alcohol and Sulphuric'.	$C_2H_5HO + H_2SO_4 = H_2O + C_2H_5HSO_4$
Propyl Alcohol	$C_3H_7(HO)$		Acetone and Hydrogen.	$(CH_3)_2CO + H_2 = C_3H_7(HO)$
Butyl Alcohol	$C_4H_9(HO)$		Quartyl Chloride and Potassium Acetate.	Exists in four Isomeric modifications.
Amyl Alcohol	$C_5H_{11}(HO)$	Fousel Oil.		During distillation of Corn, Potatoes, &c., it comes over towards the end of the process, but it requires purification.

PROPERTIES, &c.	TESTS AND REMARKS.
A colorless limpid liquid, pungent and agreeable taste and odor, burns with a pale blue flame, and feeble light, never freezes, boils at 78°C. (173°F.)	Sp. gr. of <i>Absolute Alcohol</i> , 0.7938 " " " <i>Rectified Spirit</i> , 0.835 " " " <i>Proof</i> " 0.920
A limpid colorless ethereal smelling liquid. Sp. gr. 0.790. It mixes with water and boils at 22°C. (72°F.)	Watery solutions reduce Silver salts, leaving a coating of Silver on the test tube. Boiled with Potash it gives a brownish-yellow mass.
A pungent, sour smelling liquid, crystallizable.	Sp. gr. of glacial 1.063, vapor inflammable; mixes with water.
A colorless fragrant liquid, boils at 35°C. (96°F.) burns with a white flame. Sp. gr. 0.720.	
A liquid, does not mix with water, taste and odor sweet.	Sp. gr. 1.112. The Urea decomposes any Nitrous' formed.
A pale yellow volatile liquid, smells of apples.	Sp. gr. 0.947. <i>Sweet Spirits of Nitre</i> contains this with Aldehyde and other impurities.
A colorless limpid liquid, sp. gr. 0.842; boils at 36°C—very inflammable, burns with a blue flame.	The vapor smells strongly of onions, which odor is very persistent.
Also called Acid Sulphate and Ethylsulphuric Acid.	The other salts of Ethyl are not of importance.
A colorless liquid, does not freeze, sp. gr. 0.791.	It exists in <i>two</i> isomeric modifications.
Unimportant.	
It is an oily colorless mobile liquid, odor peculiar, taste hot and acid; sp. gr. 0.811, it burns, the vapor causes coughing and difficulty in breathing.	It becomes oxydized in the air, or with Platinum black; thus, $C_3H_7HO + O_3 = H_2O + C_3H_7O$ or <i>Valerianic Acid</i> . The same is effected by Fousel Oil, Sulphuric and Potassium Bichromate.

SUBSTANCES.	FORMULÆ, &c.	SYNONYMS.	PREPARED FROM.	PROCESS AND DECOMPOSITION.
Hexyl Alcohol	$C_6H_{13}(HO)$		American Petroleum, &c.	Process complicated.
Heptyl Alcohol	$C_7H_{15}(HO)$		Hydrogen and Enanthylic Aldehyde.	$C_7H_{15}O + H_2 = C_7H_{15}(HO)$
Octyl Alcohol	$C_8H_{17}(HO)$		Castor Oil and Potash.	$C_{18}H_{34}O_2 + 2KHO = K_2C_{10}H_{18}O_4 + H_2 + C_8H_{17}(HO)$
Nonyl Alcohol	$C_9H_{19}(HO)$		American Petroleum.	
SexdecylAlcoh'l	$C_{16}H_{33}(HO)$	Cetyl Alcohol.	Spermacetti and Potash.	$C_{16}H_{31}O_2 + C_{16}H_{33} + KHO = KC_{16}H_{31}O_2 + C_{16}H_{33}(HO)$
Ceryl Alcohol	$C_{27}H_{55}(HO)$		Chinese Wax and Potash.	$C_{27}H_{53}O_2 + C_{27}H_{55} + KHO = KC_{27}H_{53}O_2 + C_{27}H_{55}(HO)$
Myricyl Alcohol	$C_{30}H_{61}(HO)$		Bees Wax and Potash.	The decomposition is like the preceding.

Besides these monatomic Alcohols we have others constituted as follows :—Vinyl Alcohol $C_2H_3(HO)$; Allyl Alcohol $C_3H_5(HO)$; Camphol $C_{10}H_{17}(HO)$; Styryl Alcohol $C_9H_9(HO)$; Cholesterine $C_{26}H_{43}(HO)$.

POLYATOMIC ALCOHOLS AND SOME

Diatomic Alcohols.	$(C_nH_{2n})''(HO)_2$	They are called Glycols. Four only of these Alcohols are known.	They are Ethene Alcohol $C_2H_4(HO)_2$; Propene Alcohol $C_3H_6(HO)_2$;
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PROPERTIES, &c.	TESTS AND REMARKS.
There are 10 of these Isomeric Alcohols, viz.: 3 primary, 4 secondary, and 3 tertiary.	Unimportant.
A colorless oily aromatic liquid, insoluble in water. Sp. gr. 0.819.	
A limpid oily aromatic liquid, sp. gr. 0.823.	It is soluble in water. Castor Oil contains Ricinoleic Acid.
A liquid, boils at 196°C. (305°F.) sp. gr. 0.899.	
Is in white crystals.	Spermacetti is composed of Palmitate of Cetyl.
A waxy substance.	This wax is the Cerotate of Ceryl.
A crystalline substance with a silky lustre.	Wax contains Myricin which is the Palmitate of Myricyl.
<p><i>Primary Aromatic Alcohols</i>:—Benzyl Alcohol $C_7H_7(OH)$; Xylol Alcohol $C_8H_9(OH)$; Cymyl Alcohol $C_{10}H_{13}(OH)$; Sycoceryl Alcohol $C_{18}H_{33}(OH)$. <i>Secondary Aromatic Alcohols</i>:—Phenol (or Carboic Acid) $C_6H_5(OH)$ and Cresol $C_7H_7(OH)$.</p>	
OF THEIR PRINCIPAL DERIVATIVES.	
Butylene Alcohol $C_4H_9(OH)_2$; Octene Alcohol $C_8H_{17}(OH)_2$.	In these Alcohols H_1 is replaced by $(OH)_2$.



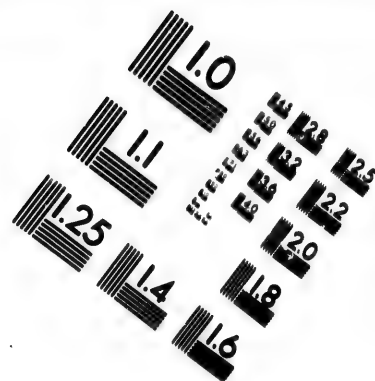
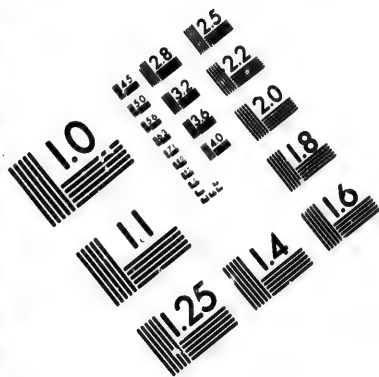
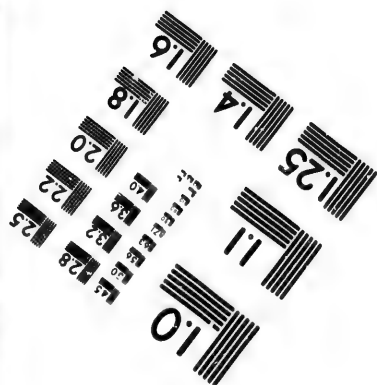
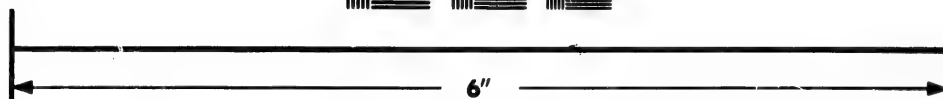
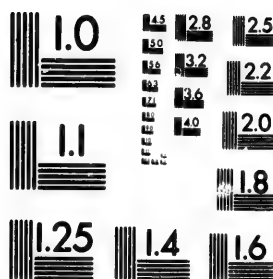


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SUBSTANCES.	FORMULÆ.	SYNONYMS.	PREPARED FROM.	PROCESS AND DECOMPOSITIONS.
Triatomic Alcohols.	$(C_nH_{2n})^{III}(HO)_3$		Only 3 are described.	Propenyl Alcohol $C_3H_5(HO)_3$; Quintenyl Alcohol $C_5H_9(HO)_3$;
	$CHCl_3$	Methenyl Chloride, Chloroform.	Ethyl Alcohol and Chlorinated Lime.	$2C_2H_5(HO) + 5CaCl_2O_2 = 2CaCO_3 + 2CaCl_2$ $+ CaH_2O_2 + 4H_2O + 2CHCl_3$
	$CHBr_3$	Bromoform.	Bromine, Potash, Alcohol.	
	CHI_3	Iodoform.	Iodine, Potash, Alcohol.	
	$C_3H_5(HO)_3$	Propenyl Alcohol or Glycerin.	Suet and Potash.	$C_5H_8(C_{18}H_{35}O_2)_3 + 3KHO =$ $3KC_{18}H_{35}O_2 + C_3H_5(HO)_3$
	$C_3H_5(NO_2)_3$	Nitro-glycerin.	Glycerin, Nitric', Sulphuric'.	$C_3H_5(HO)_3 + 3HNO_3 = 3H_2O + C_3H_5(NO_2)_3$
Tetratomic Alcohol.	$(C_4H_8)^{IV}(HO)_4$	Erythrite.	Is the only one known.	Exists in the <i>proto-coccus vulgaris</i> .
Pentatomic Alcohols.	$(C_6H_{12})^V(HO)_5$	Pinite.		Found in the sap of the Californian pine.
	$(C_6H_{12})^V(HO)_5$	Quercite.		May be obtained from acorns.
Hexatomic Alcohols.	$(C_6H_{12})^{VI}(HO)_6$	Mannite.	Exists in Manna.	Also in some sea-weeds and Mushrooms.
	$(C_6H_{12})^{VI}(HO)_6$	Dulcite.		Exists in <i>Melampyrum nemorosum</i> .

PROPERTIES, &c.	TESTS AND REMARKS.
Methenyl Alcohol $\text{CH}(\text{HO})_3$; the latter has not yet been isolated, but its ethers are important, being Chloroform, &c.	In these Alcohols $(\text{HO})_3$ replace H_3 .
A colorless liquid, sp. gr. 1.48, of vapor 4.116, boils at 61°C . (141°F .), burns with a green flame; is anæsthetic.	<i>To detect it in fluids.</i> —Put the fluid in a test tube, heat and as Cl and HCl pass off, test for them with Silver Nitrate, or with Potassium Iodide and Starch.
A heavy volatile liquid. Sp. gr. 2.9.	
A yellow crystalline solid.	
A colorless viscid liquid, sweet, sp. gr. 1.27, not fermentable, mixes with water.	Suet is composed of the Stearate of Glycerin. Heated Glycerin gives off an irritating vapor called Acrolein $\text{C}_3\text{H}_4\text{O}$
A heavy oily explosive liquid, used for blasting.	Extremely dangerous to handle as it is so explosive.
A saccharine substance in large transparent crystals.	Sweet, soluble in water and not fermentable.
Is in hard sweet nodules.	Not fermentable. Two Pentatomic Alcohols only are known; this and the next one to be described.
Is in hard gritty soluble crystals.	
Thin 4-sided prisms, sweet, soluble in water.	Not fermentable except under unusual conditions.
Is in sweet crystalline prisms.	Most vegetable sugars are included in this class of Alcohols.

Class III. HALOID ETHERS.—These are compounds of hydro-carbon radicals with the Halogens Cl, Br and I, such as $(\text{CH}_3)_2\text{Cl}$, or Methyl Chloride; $(\text{C}_2\text{H}_5)_2\text{Br}$, Ethyl Bromide; $(\text{C}_3\text{H}_7)_2\text{I}$, or Propenyl Iodide, which have been already described at page 80.

Class IV. OXYGEN ETHERS—which are compounds of hydro-carbon radicals with O; examples, $(\text{C}_2\text{H}_5)_2\text{O}$ or Ethyl Oxide; $(\text{C}_2\text{H}_4)_2\text{O}$ Ethene Oxide, &c., they are also called *Alcoholic Oxides* and are described at page 82.

Class V. MERCAPTANS—so called from their readiness to unite with Mercury (*corpora mercurio apta*) or Sulphur Alcohols, are compounds analogous to the Alcohols, but the O of the HO is replaced by S as in Methyl Mercaptan $(\text{CH}_3)_2\text{HS}$ which however has been fully described at page 80, as well as Ethyl Mercaptan $\text{C}_4\text{H}_9\text{HS}$ at page 82.

Class VI. SELENIUM ALCOHOLS are analogous to the Mercaptans but Se is substituted for the S in these compounds.

Class VII. SULPHUR AND SELENIUM ETHERS are similar compounds to the Oxygen Ethers, but S and Se are substituted for the Oxygen in these preparations.

Class VIII. COMPOUND ETHERS are produced by the substitution of an alcohol-radical for an atom of H of an acid, in precisely the same manner as an ordinary metallic salt is formed; $(\text{C}_2\text{H}_5)_2\text{H.SO}_4$ Monethylic Sulphate; $(\text{C}_2\text{H}_5)_2\text{SO}_4$ Diethylic Sulphate. These preparations are also commonly regarded as *Ethereal Salts*. Numerous examples have been already given in the preceding tables.

Certain vegetable principles called *Glucosides* are regarded as Compound Ethers of the Alcohols, these on ebullition with a dilute acid yield glucose, hence the name; they are:—

1. Æsculin $\text{C}_{21}\text{H}_{32}\text{O}_{11}$ from Horse-chestnuts.
2. Amygdalin $\text{C}_{20}\text{H}_{27}\text{NO}_{11} \cdot 3\text{H}_2\text{O}$ from Almonds.
3. Cathartic Acid $\text{C}_{180}\text{H}_{122}\text{N}_2\text{SO}_{82}$ from Senna.
4. Chitin $\text{C}_7\text{H}_{13}\text{NO}_4$ from some Insects.
5. Colocythin $\text{C}_{28}\text{H}_{44}\text{O}_{23}$ from Bitter apple.
6. Gallotannin $\text{C}_{27}\text{H}_{22}\text{O}_{17}$ from Nutgalls.
7. Convolvulin $\text{C}_{24}\text{H}_{36}\text{O}_{16}$ from Jalap.
8. Glycyrrhizin $\text{C}_{24}\text{H}_{34}\text{O}_8$ from Licorice.
9. Digitalin $\text{C}_{27}\text{H}_{44}\text{O}_{11}$ from Foxglove.
10. Phlorizin $\text{C}_{31}\text{H}_{44}\text{O}_{10} \cdot 2\text{H}_2\text{O}$ from Apple-tree bark.
11. Salicin $\text{C}_{12}\text{H}_{16}\text{O}_6$ from Poplars and Willows.
12. Elaterin $\text{C}_{28}\text{H}_{40}\text{O}_8$ from Squinting Cucumbers.
13. Helicin $\text{C}_{14}\text{H}_{18}\text{O}_6$ from Salicin and Nitric'.

14. Guaiacin $\text{C}_{20}\text{H}_{22}\text{O}_5$ (?) from Lignum vitae.
15. Thujin $\text{C}_{26}\text{H}_{28}\text{O}_{12}$ from Arbor vitæ.
16. Jalapin $\text{C}_{21}\text{H}_{26}\text{O}_{16}$ from Jalap.
17. Myronic' $\text{C}_{16}\text{H}_{18}\text{NS}_2\text{O}_{10}$ from Mustard.
18. Santonin $\text{C}_{18}\text{H}_{16}\text{O}_8$ from Santonica.
19. Quercitrin $\text{C}_{22}\text{H}_{30}\text{O}_{17}$ from Gall oak.
20. Scammonin $\text{C}_{22}\text{H}_{26}\text{O}_{16}$ from Scammony.
21. Populin $\text{C}_{20}\text{H}_{22}\text{O}_8$ from the Aspen.
22. Saponin $\text{C}_{18}\text{H}_{20}\text{O}_8$ from Soap wort.
23. Solanine $\text{C}_{48}\text{H}_{71}\text{NO}_{16}$ from Bittersweet.
24. Arbutin $\text{C}_{12}\text{H}_{16}\text{O}_6$ from Bearberry.
25. Xanthorhamnin $\text{C}_{28}\text{H}_{32}\text{O}_{14}$ from Buckhorn.

Class IX. ALDEHYDES.—These are compounds produced by the oxydation of Alcohols by which Hydrogen is removed; thus, $C_2H_5O + O = H_2O + C_2H_4O$ or Aldehyde; they readily undergo decomposition, becoming further oxydized by the absorption of O from the atmosphere, and are thus converted into organic acids, example $2C_2H_4O + O_2 = 2C_2H_3O_2$ or Acetic'. Aldehydes can be reconverted into Alcohols by means of nascent H, they are.—

Formic	Aldehyde	CH_3O	Enalphylic	Aldehyde	$C_7H_{14}O$	Cumic	Aldehyde	$C_{10}H_{18}O$
Acetic	"	C_2H_4O	Caprylic	"	$C_8H_{16}O$	Sycocerylic	"	$C_{15}H_{30}O$
Propionic	"	C_3H_6O	Euodlic	"	$C_{11}H_{22}O$	Cinnamic	"	C_9H_8O
Butyric	"	C_4H_8O	Acrylic	"	C_3H_4O	Salicylic	"	$C_7H_6O_2$
Valeric	"	$C_5H_{10}O$	Benzoic	"	C_7H_6O	Anisic	"	$C_8H_8O_2$
Caproic	"	$C_6H_{12}O$	Toluic	"	C_8H_8O			

That class of substances called *Glucoses* may be considered to be the Aldehydes of Alcohols; these are all composed of $C_6H_{12}O_6$ they are:—

1. Ordinary *Glucose* or Grape sugar.
2. *Levulose* from Cane sugar and Nitric'
3. *Maltose* from Malt.
4. *Mannitose* from Mannite.
5. *Galactose* from Milk sugar and an acid.
6. *Inosite* from Flesh of animals.
7. *Sorbitol* from Red-ash berries.
8. *Eucolyn* from Australian Manna.

Polyglucosic Alcohols are compounds that contain less H and O than the molecules of Glucose from which they are supposed to be formed; thus, $2C_6H_{12}O_6$ (or Glucose)— H_2O yield $C_{12}H_{22}O_{11}$ or a substance called Diglucosic Alcohol, which is ordinary Cane sugar the only one of this series known, though others are supposed to exist; while Starch, Cellulose and allied substances are to be regarded, as Oxygen Ethers or Anhydrides of the higher orders of these Polyglucosic Alcohols. The principles included under this head are:—

Melitose $C_{12}H_{22}O_{11}$ from the Eucalyptus.
Mycose $C_{12}H_{22}O_{11}$, $2H_2O$ from Ergot of Rye.
Arabin $C_{12}H_{22}O_{11}$ from Gum Acacia.

Trehalose $C_{12}H_{22}O_{11}$, $2H_2O$ from Trehala Manna.
Lactose $C_{12}H_{22}O_{11}$, H_2O from Milk.

Mucilage from Salep; *Bassoria* from Gum Tragacanth, and *Cerasin* from Cherry tree gum, are all of the same composition as Starch $C_6H_{10}O_5$, or more probably $C_{12}H_{20}O_{14}$. Starch is also included under this series as well as *Dextrine*, which is formed by boiling it with Sulphuric Acid or with Diastase (a principle found only in germinating grain), these two agents make the Starch take up one molecule of H_2O and it then splits up; thus, $C_{12}H_{20}O_{14} + H_2O = C_6H_{12}O_6$ (or Glucose) $+ 2C_6H_{10}O_5$ (or Dextrine); the latter is sold in commerce under the name of *British Gum*, and is usually prepared by heating common potato-starch at a temperature of $400^\circ C$ ($752^\circ F$) till it acquires a yellowish tint and becomes entirely soluble in water. *Inulin* from Dahlia roots, as well as *Lignin* and *Cellulose* from plants, have also the same composition as Starch, and like it are also convertible into Grape Sugar. *Glycogen* $C_6H_{10}O_5$, a principle derived from the liver of animals (exists in Cod Liver Oil) and also from the muscles of the fœtus; white, amorphous, starch-like and not fermentable, is also convertible into Glucose by the action of the blood, salivary and pancreatic secretions, or by boiling it with dilute acids or with *Diastase*.

Class X. ORGANIC ACIDS.—These are formed from the Alcohols by the substitution of O for H_2 , and they may be regarded as compounds of (HO) Hydroxyl with oxygenated radicals; thus, C_2H_5O (Alcohol) $+ O_2$ becomes $H_2O + C_2H_3O_2$ (or Acetic) $= C_2H_3(HO)$.

An Alcohol may produce one or several acids; the number, however, which each Alcohol will furnish may be ascertained with accuracy by finding out how often the group CH_2HO can be formed from its molecule, for the production of the acid is due to the substitution of O for the H_2 in this group, and hence results an acid-radical COHO called *Oxetyl*; thus, Ethene Alcohol $C_2H_3O_2 = 2CH_2HO$ which may become oxydized and produce $C_2H_3O_3$, i. e. $CH_2HO.COHO$ or Glycollic, or it may become further oxydized and furnish $C_2H_3O_4$, i. e. $COHO.COHO$ or Oxalic: according as H_2 or $2H_2$ have been removed and O or O_2 have been substituted for the H so displaced. And moreover the basic power of the acid depends upon the number of molecules of *Oxetyl* which it contains, which is the same as saying that it depends upon the number of Hydrogen molecules (H_2) which have been removed from the original Alcohol and that have been replaced by a corresponding quantity or proportion of Oxygen.

The following is a list of the vegetable Acids:—

Formic'	Acetic'	Propionic'	Butylic'	Valerianic'	Caproic'	Enanthylic'	Meconic'
Capric'	Rutic'	Pelargonic'	Lauric'	Myristic'	Palmitic'	Margaric'	Quinic'
Stearic'	Arachic'	Behenic'	Cerotic'	Melysic'	Amylic'	Pyroterebic'	Sulphobenzoic'
Damaluric'	Damolic'	Moringic'	Cimicic'	Crotonic'	Physetoleic'	Hypogæic'	Tannic'
Gaidic'	Oleic'	Elaidic'	Angelic'	Doeglic'	Brassic'	Erucic'	Mannitic'
Parasorbic'	Camphic'	Hydrobenzoic'	Benzoic'	Toluic'	Xylic'	Cullic'	Sulphonaphthallic'

Alpheymic'	Hippuric'	Cinnamic'	Atropic'	Glycollic'	Lactic'	Oxybutyric'	Racemic'
Oxyvaleric'	Leucic'	Peruvic'	Guainic'	Salicylic'	Creosotic'	Convulvulinolic'	Saccharic'
Phloretic'	Thymotic'	Coumaric'	Oxybenzoic'	Parabenzoic'	Formobenzoic'	Jalapinolic'	Isethionic
Carboacetic'	Anisic'	Benzilic'	Oxalic'	Malonic'	Succinic'	Ricinoleic'	Rhodizonic'
Pyrotartaric'	Adipic'	Pimalic'	Suberic'	Anchoic'	Sebic'	Thymylcarbonic'	Mucic'
Rocellin'	Fumaric'	Malic'	Itaconic'	Citraconic'	Mesaconic'	Camphoric'	Comenic'
Mellitic'	Quinonic'	Orsellinic'	Evernic'	Phthallic'	Terephthallic'	Insolinic'	Sulphacetic'
Glyoxylic'	Glyceric'	Oxysalicylic'	Euetic'	Piperic'	Malic'	Aconitic'	Pyromeconic'
Carballylic'	Erythric'	Gallie'	Tartaric'	Citric'	Opianic'	Hemipinic'	Sulphopropionic'

Class XI. ACID HALIDES are compounds of the organic acids with the Halogens Cl, I and Br—they are defined to be compounds of oxygenated or acid radicals with Cl, &c., example C_2H_3OCl or Acetyl Chloride.

Class XII. ACID OXIDES frequently termed *Anhydrous Acids* or *Anhydrides*. These are to be regarded as holding the same position to the acids, that the Alcoholic oxides or Oxygen Ethers do to the Alcohols, example $(C_2H_3O)_2O$ or Acetic Oxide.

Class XIII. KETONES—These are substances derived from Aldehydes by substituting an *Alcohol radical* for an atom of H in a group of its atoms of COH; thus, CH_3COH Acetic Aldehyde becomes CH_3COCH_3 or Acetone.

Class XIV. AMINES or COMPOUND AMMONIAS.—These are compounds formed by the substitution of *Alcohol radicals* for the H in NH_3 (Ammonia); and as one or more molecules (such as $NH_3, N_2H_6, N_3H_9, N_4H_{12}$) may be engaged in the formation of the compound, so they are termed *Monamines, Diamines, Triamines*, &c. These are also said to be Primary, Secondary and Tertiary according as one or more of the H atoms are replaced by the radical.

It is not necessary however that each H atom should be replaced by the same radical, these may indeed all differ, the following are examples.

$N \begin{Bmatrix} H \\ H \\ H \end{Bmatrix}$	$N \begin{Bmatrix} CH_3 \\ H \\ H \end{Bmatrix}$	$N \begin{Bmatrix} CH_3 \\ CH_3 \\ H \end{Bmatrix}$	$N \begin{Bmatrix} CH_3 \\ CH_3 \\ CH_3 \end{Bmatrix}$	$N \begin{Bmatrix} CH_3 \\ CH_3 \\ C_2H_5 \end{Bmatrix}$	$N \begin{Bmatrix} CH_3 \\ C_2H_5 \\ C_2H_5 \end{Bmatrix}$
Ammonia.	Methylamine.	Dimethylamine.	Trimethylamine.	Dimethyl—Ethylamine.	Methyl—Ethyl—Amylamine.

The Amines are sometimes called *Alcohol bases*, they are also considered to be compounds of Alcohol-radicals with Amidogen $(\text{NH})^I$, Imidogen $(\text{NH})^{II}$ and Trivalent $(\text{N})^{III}$. These compounds unite with acids and form salts. Those in which the H is wholly replaced with radicals are called *Nitriles*.

Under this head the vegetable Alkaloids are to be considered as they appear to be substitution products of NH_3 ; as well as some other substances that are derived from the animal kingdom, such as:—Sarcine, Guanine, Guanidine, Xanthine, Creatine, Creatinine, and Sarcosine; the vegetable Alkaloids are Morphine, Narcotine, Thebaine, Quinine, Cinchonine, Quinicine, Quinidine, Cinchonidine, Quinoidine, Strychnine, Brucine, Veratrine, Colchicine, Caffeine, Theine, Apomorphia, Codeia, Thebaia, Papaverine, Opianine, Narceine, Cryptopia, Meconine, Laudanine, Codamine, Pseudomorphia, Protopine, Laudanosine, Hydrocotarnine, Cinchovatine, Quinicine, Theobromine, Berberine, Piperine, Conine, Nicotine, Sparteine, Conhydrine, Daturine, Atropine, Solanine, Aconitine, Delphinine, Emetine, Curarine, Nectandrine, Beberine, Capsicine, Pelosine, Hyosciamine, Lobeline, Physostigmine, Sanguinarine.

Class XV. ALCOHOLIC AMMONIUM COMPOUNDS.—These are organic compounds containing Pentad Nitrogen (N^V) in combination with Hydrogen, (N is however usually considered to be a triad, though it is sometimes also Pentad as seen in these substances). The H however in these compounds is always replaced more or less by Alcohol-radicals; thus:—

$\text{N}^V \left\{ \begin{array}{l} \text{C}_2\text{H}_5 \\ \text{H} \\ \text{H} \\ \text{H} \\ \text{H} \\ \text{Cl} \end{array} \right.$	Ethylammonium Chloride.	$\text{N}^V \left\{ \begin{array}{l} \text{C}_2\text{H}_5 \\ \text{C}_2\text{H}_5 \\ \text{H} \\ \text{H} \\ \text{H} \\ \text{Cl} \end{array} \right.$	Diethylammonium Chloride.	$\text{N}^V \left\{ \begin{array}{l} \text{C}_2\text{H}_5 \\ \text{C}_2\text{H}_5 \\ \text{C}_2\text{H}_5 \\ \text{C}_2\text{H}_5 \\ \text{H} \\ \text{Cl} \end{array} \right.$	Triethylammonium Chloride.	$\text{N}^V \left\{ \begin{array}{l} \text{C}_2\text{H}_5 \\ \text{C}_2\text{H}_5 \\ \text{C}_2\text{H}_5 \\ \text{C}_2\text{H}_5 \\ \text{C}_2\text{H}_5 \\ \text{Cl} \end{array} \right.$	Tetraethylammonium Chloride.	$\text{N}^V \left\{ \begin{array}{l} \text{C}_2\text{H}_5 \\ \text{C}_2\text{H}_5 \\ \text{C}_2\text{H}_5 \\ \text{O}_2\text{H} \\ \text{C}_2\text{H}_5 \\ \text{HO} \end{array} \right.$	Tetraethylammonium Hydrate.
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Class XVI. PHOSPHORUS, ARSENIC AND ANTIMONY COMPOUNDS are exactly analogous to the N compounds described in classes 14 and 15. They are also very numerous and are called *Phosphines*, *Stibines* and *Arsines*. These metals replacing as it were the N in the Ammonia, both in its triad and pentad conditions; examples:—

$P^{III} \left\{ \begin{array}{l} C_2H_5 \\ C_2H_5 \\ C_2H_5 \end{array} \right. \text{Triethyl-Phosphine.}$	$P^V \left\{ \begin{array}{l} CH_3 \\ CH_3 \\ CH_3 \\ CH_3 \\ Cl \end{array} \right. \text{Tetramethylphosphonium Chloride.}$	$Sb^{III} \left\{ \begin{array}{l} C_2H_5 \\ C_2H_5 \\ C_2H_5 \end{array} \right. \text{Triethyl-Stibine.}$	$Sb^V \left\{ \begin{array}{l} C_2H_5 \\ C_2H_5 \\ C_2H_5 \\ C_2H_5 \\ HO \end{array} \right. \text{Tetethyl-Stibonium Hydrylate.}$	$As^{III} \left\{ \begin{array}{l} C_2H_5 \\ C_2H_5 \\ C_2H_5 \end{array} \right. \text{Triethyl-Arsine.}$	$As^V \left\{ \begin{array}{l} CH_3 \\ C_2H_5 \\ C_2H_5 \\ C_2H_5 \\ Cl \end{array} \right. \text{Methyl-triethyl-Arsonium Chloride}$
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Class XVII. ORGANO-METALLIC COMPOUNDS.—The foregoing class might be included in this one but omitting it, the present class contains all other compounds formed between metals and organic radicals, such as Ethyl, Methyl and Amyl, these are: $Zn^{II} (C_2H_5)_2$, $Al^{III} (CH_3)_3$, and $Pb^{IV} (C_2H_5)_4$.

Class XVIII. AMIDES may like Amines be *Monatomic*, *Diatomic* or *Triatomic*, *Primary*, *Secondary* or *Tertiary* and for the same reasons as were given regarding the Amines, which they resemble in composition in every respect but one, and that is that they form their compounds with *Acid-radicals* replacing the H of Ammonia, instead of the Alcohol-radicals as the Amines do. Those which contain (NH^{II}) *Imidogen* combined with Dyad Acid-radicals are named *Imides*. Examples:—

C_2H_5O, H_2N Acetamide; $(C_2H_5O)_2HN$ Succinimide.

Class XIX. AMIC ACIDS.—These are composed of dyad and triad acid-radicals in combination with both Amidogen (NH_2) and Hydroxyl (HO) —examples: $(C_2H_5O)_2, HO, H_2N$ Succinamic Acid.

Class XX is supposed here to embrace all those Organic substances that cannot with correctness be included in any of the preceding classes or groups. These substances are still exceedingly numerous and are derived more especially from the animal and vegetable kingdoms, such as Albumen, Fibrin, Casein, &c. To enter into a full description of these in a condensed work of this kind, would be superfluous: one however Cyanogen is of such importance that more than a passing remark concerning it becomes necessary.

SUBSTANCES.	FORMULÆ, &c.	SYNONYMS.	PREPARED FROM.	DECOMPOSITIONS.
Cyanogen	CN ^{II} Symbol Cy.		Heat Mercury Cyanide.	$\text{Hg}^{II}(\text{CN})_2 = 2\text{CN} + \text{Hg}$
	CNH or HCy	(1) Hydrated. { Hydrocyanic' Prussic'	Potassium Ferrocyanide and Sulphuric'	$2\text{K}_2\text{Fe}^{II}\text{Cy}_6 + 3\text{H}_2\text{SO}_4 =$ $\text{K}_2\text{Fe}^{II}\text{Cy}_6 + 3\text{K}_2\text{SO}_4 + 6\text{HCy}$
		(2) Anhydrous. {	Mercuric Cyanide and Sulphuretted Hydrogen	$\text{Hg}^{II}(\text{CN})_2 + \text{H}_2\text{S} = \text{Hg}^{II}\text{S} + 2\text{CNH}$
	KCy	Potassium Cyanide.	Potassium Carbonate and Ferrocyanide.	$\text{K}_2\text{Fe}^{II}\text{Cy}_6 + \text{K}_2\text{CO}_3 = \text{KCyO} + \text{Fe} + \text{CO}_2 +$ 5KCy
	Hg ^{II} Cy ₂	Mercuric Cyanide.	Mercuric Oxide and Prussic'	$\text{HgO} + 2\text{HCy} = \text{Hg}^{II}\text{Cy}_2 + \text{H}_2\text{O}$ boil and evaporate.
	CNHO	Cyanic'	Heat dried Cyanuric'	
	C ₂ N ₂ H ₂ O ₂	Fulminic'	Silver, Ethyl Nitrite and Nitrous'	$\text{Ag}_2 + \text{C}_2\text{H}_5\text{NO}_2 + \text{HNO}_2 = \text{Ag}_2\text{C}_2\text{N}_2\text{H}_2\text{O}_2 +$ $2\text{H}_2\text{O}$
	C ₂ N ₂ H ₂ O ₃	Cyanuric'	Urea and Chlorine gas.	NH ₄ Cl which forms must be dissolved out with water.
	NH ₄ CNO "Urea"	Ammonium Cyanate.	Cyanic' vapor & NH ₃ gas.	A white crystalline solid is formed which
Ferrocyanogen	K ₂ Fe ^{II} Cy ₆	Potassium Ferrocyanide	Horn, Hide parings, old Iron & Potash Carbonate.	$6\text{KCN} + \text{Fe} = \text{K}_2\text{S} + 5\text{Fe}^{II}\text{S} + \text{K}_2\text{Fe}^{II}\text{Cy}_6$ this Sulphur is derived from the tissues used.
	4Fe ^{III} Cy ₃ , 3Fe ^{II} Cy ₃	Ferrio Ferrocyanide.		$3\text{K}_2\text{Fe}^{II}\text{Cy}_6 + 2\text{Fe}_2^{III}\text{Cl}_6 = 12\text{KCl} + 4\text{Fe}^{III}\text{Cy}_3$ $3\text{Fe}^{II}\text{Cy}_3$
Ferriocyanogen	K ₂ Fe ^{III} Cy ₆	Red Prussiate.	Ferrocyanide & Chlorine.	

CONTAINING NITROGEN.

PROPERTIES.	TESTS AND REMARKS.
A colorless inflammable gas, burns with a purple flame, liquifiable, very poisonous; sp. gr. 1.806.	It must be collected over Mercury.
A colorless solution, very poisonous, may be Hydrated or Anhydrous. Sp. gr. of the former is 0.997. It does not mix readily with water, odor peculiar.	<i>Tests for Prussic</i> —1. Its odor; 2. <i>Iron Sulphate and Potash</i> gives <i>Prussian blue</i> ; 3. Silver Nitrate gives a white precipitate, soluble in Ammonia.
A thin colorless volatile fluid, intensely poisonous, sp. gr. 0.696. In cubic or octahedral crystals, soluble in water.	(4) <i>Ammonium Sulphide</i> and a <i>Persalt of Iron</i> gives <i>blood-red</i> .
In white translucent prisms.	(5) If any change be produced on the addition of Iodo-cyanide of Mercury or Potassium; it indicates the presence of some other acid, introduced often to retard decomposition in the HCy solution.
A limpid colorless pungent liquid, decomposes speedily. The Fulminate separates in brilliant plates, fearfully explosive.	<i>To detect the strength of any solution of Prussic</i> .—Add a solution of Silver Nitrate to 100 grains of the solution, as long as a precipitate falls, collect this, dry and weigh it, divide its weight by 5, the answer will be the per-centage; thus, if 20 grains fell, there is 4 per cent. present.
In colorless efflorescent crystals.	
when heated gives off NH ₃ and Urea is left behind.	
Large transparent yellow crystals; called Yellow Prussiate of Potash.	
Called Prussian Blue and used as a pigment.	
Ruby-red permanent crystals, called Red Prussiate of Potash.	

Isomerism, Metamerism and Polymerism. When bodies possess the same per-centage composition, but differ in physical properties, they are said to be *Isomeric*. Such instances are comparatively rare among Inorganic substances, but in Organic we meet with them very frequently; some indeed resembling each other so closely that not only do they present the same empirical formulæ, but also undergo analogous decompositions and transformations with heat and with chemical reagents, as for example Oils of Turpentine, Orange and Juniper, which are all composed of $C_{10}H_{16}$; to such the term *Isomerism* more correctly belongs: for there is a second group of these bodies which, though presenting the same empirical formulæ, do not yield analogous products with heat, &c., such are said to be *Metameric*: while a third group is called *Polymeric*, because their molecule consists of two or three molecules of the isomeric combined, as is the case with $C_{20}H_{32}$, $C_{20}H_{40}$, &c. Among these latter again we may meet with some that are truly *Isomeric* and others that prove themselves to be *Metameric* when acted upon by chemical agents or by heat. The formation of the *Isomerides, Metamerides and Polymerides* can only be accounted for on the supposition that the atoms of which each is composed must be united together differently.

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